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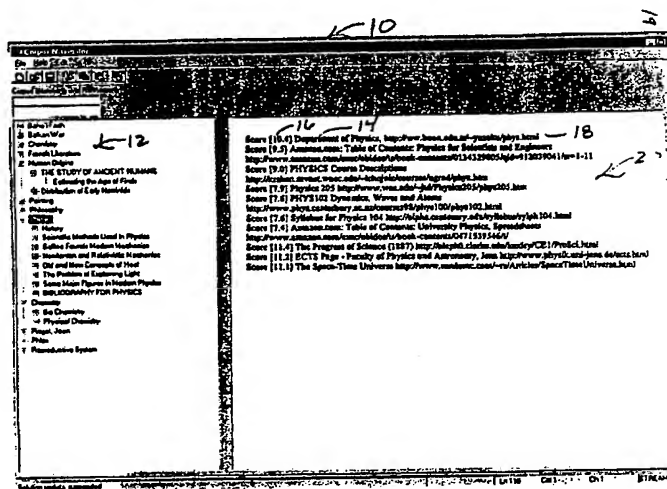


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(54) Title: **SYSTEMS AND METHODS FOR EMPLOYING AN ORTHOGONAL CORPUS FOR DOCUMENT INDEXING**



(57) Abstract

The invention provides for indexing and cataloging of content on the Internet, as well as from other stores of information, may be performed by applying a process that employs an orthogonal corpus, or corpora, of information, such as an Encyclopedia. To this end, the processes described herein identify the topics discussed within the corpus. The process also identifies within the corpus a set of keywords that are relevant to the topics presented in the corpus. The keywords associated with a topic may be employed to identify documents stored in another database that are related to the topic. A graphical representation of the index of topics found in the corpus may then be generated, with individual topics operating as links to these related documents. Thus, a user interested in reviewing content in the corpus related to a certain topic, may also activate a link in the graphical representation of the index to access other documents that have been identified as related to the topic of interest to the user.

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SYSTEMS AND METHODS FOR EMPLOYING AN ORTHOGONAL CORPUS FOR DOCUMENT INDEXING

Field of the Invention

The invention provides systems and methods for organizing a collection of information, such as a database of documents, and more particularly, to systems and methods for classifying information with respect to a set of independent concepts, and applications of the classified information.

Background of the Invention

The computer-based storage of information has become the norm for our knowledge-based society, and today huge databases of computer-stored information are available to researchers. For example, through the World Wide Web service, the Internet has become an enormous repository of readily accessible information. However, the sheer volume of information maintained on the World Wide Web becomes problematic when someone wishes to identify those resources, or documents that are maintained on the Internet and that are related to a certain topic. The problem is that a simple search request for information stored on the Internet and related to a certain topic returns an enormous volume of information, most of which is extraneous and irrelevant. This problem arises in part from the difficulty that existing Internet retrieval systems have with prioritizing and categorizing documents stored on the World Wide Web. Today, most systems for organizing content on the web work by searching through a document stored on the web, and associating with the document a set of key words that represent the information contained on the reviewed pages. Accordingly, documents can be organized according to the keywords that appear in the document.

5 However, lists of keyword, although helpful, lack an identifiable hierarchy of
concept and therefore fail to provide a topic-based system for organization and
document retrieval. Thus, keyword lists are less powerful tools for document research
than topic-based hierarchal systems of document organization, such as tables of content,
or topic indexes. Today there is a need for a "table of content" for the World Wide Web.
10 Such a table of content would provide a more powerful metaphor for using the Web as a
research tool and would provide a flexible platform on which other research tools could
be built. As such, there is a need for improved systems for organizing information
stored in a computer database, such as the World Wide Web.

15 Summary of the Invention

 The systems and methods described herein provide systems for document
indexing and scoring of content on a computer database, such as the World Wide Web.
The systems generally include an orthogonal corpus that may comprise a collection of
blocks of text, and that may be employed to index and score textual information for
20 applications in retrieving, classifying, or browsing over a set of documents.

 An orthogonal corpus, as the term is employed herein, may be understood to
encompass, without being limited to, any collection of blocks of text that are outlined or
referenced by a table of contents, topic index, chapter heading or other topical indicia
where each topic either stands alone or is an identified subpart (subtopic) of another
25 topic, forming a tree of topics and their descendant subtopics. Encyclopedias, text and
reference books, periodicals, web sites, dictionaries, thesauri, the library of congress, the
Dewey decimal system, and glossaries are examples of, surrogates for, or extenders of
orthogonal corpora. A set of topics is understood as orthogonal in the sense that
substantially every member topic (e.g., chapter or article) covers a different concept or
30 substantially different concept than any other topic under the same ancestor topic in the
tree. A topic in one practice may be assumed to include or not include, its ancestor
topics or underlying subtopics.

 The orthogonal construction, or decomposition, of a corpus provides for
algorithmic identification of keywords in each topic, which distinguish it from its
35 sibling, cousin, ancestor, or descendent topics. Keywords may be employed to

5 numerically score over an underlying pool of documents. Alternatively, if more practical for a given application, such as when working with a large document collection, rather than individually score all documents in the collection against the keywords, then a set of search words may be generated to identify a subset of candidate documents for scoring.

10 Parameters employed during the scoring process may relate to the identification of keywords and their refinement into a set of search words, with weightings for associated document or sub-document scoring. The scoring, search term, and keyword methods may employ conventional information retrieval techniques including the use of synonyms, stemming, frequency, proximity, stop words, hyponyms, and synonyms.

15 For purposes of clarity certain terms will now be described, although the understandings set forth are not to be understood as limiting and are only provided for purposes of achieving clarity by way of providing examples. The term "word" as employed herein may be understood to encompass a lexical type found in a common or specialty dictionary of any language. The term "phrase" as employed herein may be understood to encompass any sequence of one or more words. Heretofore for simplicity we use "Word" to mean "Word or Phrase." The term "synonym group" shall be understood to encompass a set of words which may be used as alternates for a given word. Each word in a synonym group has a similar or identical meaning. The term "topic" shall be understood to encompass textual content typically having a title, having
20 corresponding text, concerning a single topic, or covering a set or tree of related subtopics. The term "subtopic" shall be understood to encompass a block of text within a Topic. Typically, a subtopic may be identified by its subtopic header or other outline indicator. In different calculation contexts, subtopics may or may not be included as part of parent topics. The term "word_count" maybe understood as an integer count of the number of times a word or a word in its synonym group occurs in a given topic or text area, potentially including text in the title and headers and any text elements in that text. The term "word_frequency" may be understood to encompass the word count in a text area divided by the number of words total in that text. A word_map is a representation of textual content within a text area that is more precise than a word_count. A word_map
30 may describe a word's relative location in the text, its linguistic type or contexts of use,

5 its prominence indicators such as use in a title or highlighting fonts. The term
orthogonal corpus may be understood to encompass a collection of topically organized
information referenced by a table of contents and/or index, where each topic is clearly
10 identified as a SubTopic of a topic or else stands alone. Nodes in the table of contents
tree may represent topics. The information may be understood as orthogonal in the
sense that a stand-alone topic (e.g., chapter or article) covers a substantially different
concept than any other stand-alone topic, and any subtopic expresses a substantially
different concept from any other subtopic within the same parent topic. The term
15 document may be understood to encompass formatted textual content with topic
beginnings, endings, and marked hierarchy. A document may contain one or more
topics and may include subtopics. A corpus may include one or more documents. The
relationship between documents and topics is not mandated, though in some
embodiments each document to represent one top-level topic along with its subtopics.
The term "discovered document" may be understood to encompass a document (or a set
of documents such as a web site or portion of a web site) which is being scored. Scoring
20 of a discovered document may be relative to one or more corpus documents or corpus
topics. In one practice, scoring measures the degree of topical relevance to the corpus
topics. The discovered document will often be a member of a search result set.

25 More particularly, the systems and methods described herein include methods for
processing a body of reference material to generate a directory for accessing information
from a database. These methods may comprise processing the body of reference
material to identify a hierarchical organization of a plurality of topics. Additionally, the
processes may include the step of associating with at least one of the topics a portion of
the reference material and processing the assigned portion of reference material to
30 generate a plurality of search keys representative of search strings for selecting
information from the database. The process may then apply the search keys to the
database to retrieve information from the database and may create an association
between the at least one topic and the information retrieved from the database.

35 In an optional step, the methods described herein may create a graphical interface
that is representative of the identified hierarchical organization of a plurality of topics

5 for allowing a user to access information retrieved from the database and having an association with the topic. Accordingly, the user may be provided with a graphical interface that allows the user to activate, typically by clicking with a mouse, a graphical representation of a topic to identify a set of links to content, such as web pages that are associated with the topic selected by the user.

10 In one practice, processing the body of reference material includes processing a body of reference material that has been selected from the group consisting of an encyclopedia, a dictionary, a text book, a novel, a newspaper, or a website. Processing the material may include identifying a hierarchical organization of a plurality of substantially orthogonal topics. This may include identifying a table of contents for the
15 body of reference material, identifying an index for the reference material, identifying chapter or subchapter headings within the reference table, identifying definition entries within a dictionary, and other similar operations that identify different topics that occur within the reference material.

20 Optionally, when processing a body of reference material, the process may normalize the identified hierarchical organization of the plurality of topics.

In one practice when processing the assigned text, the process includes a step of generating a word map that is representative of a statistical analysis of the words contained in the assigned text. Generating the word map may include performing a word count process for determining word frequency of a word within the assigned text
25 and for employing the word frequency for determining the relevance of a word to the associated topic. Processing the assigned text for different topics may also include a step of identifying a set of key words that have an associated measure intradocument orthogonality.

30 In an optional step, processing the assigned text may include identifying a set of synonyms for extending the search keys. Further, a subset of search keys may be selected that have a predetermined measure of correlation to the topic. The search keys may be applied to the database such as through an Internet search engine, to discover documents that are related to the search keys. Optionally, the Internet search engine may be a meta-search engine.

5 Once documents have been discovered from the database that are related to the search keys, documents may be further processed to determine their relationship to the topics associated with the search keys.

 In the methods described herein creating an association between the at least one topic and the information retrieved from the database may include capturing a location
10 pointer that is associated with the information retrieved from the database. Creating that association may include generating a data structure for the topic which allows storing location pointers that are associated with information retrieved from the database.

 In another aspect, the systems and methods described herein include systems for organizing a collection of documents. Such systems may comprise an orthogonal corpus
15 of information that is arranged according to an index of topics, a keyword generator for generating a set of keywords representative of a documents associated with a topic in the index of topics, a scoring system for processing documents within the collection of documents to associate with at least a portion of the documents a score representative of the document's association to a particular topic, and a graphical representation for
20 depicting at least a portion of the index of topics and having respective portions of the graphical representation linked to documents associated with a respective portion of the index of topics.

 In a further embodiment the systems of the invention may include systems for extending the content of the document. These systems can include a parser for selecting
25 terms within the document to be extended, an orthogonal corpus of information arranged according to an index of topics, a keyword generator for generating a set of key words representative of a documents association with a topic in the index of topics, and a linking system for processing the documents within a collection of documents, to associate with at least a portion of the document, a score representative of the documents
30 association to a particular topic and for providing the first document with links to the collection of documents for extending the content of that document.

 Accordingly, the systems and methods described herein may leverage the electronically stored content of the World Wide Web in an intelligent and meaningful way, to provide a database of content organized under an orthogonal and hierarchical
35 index of topics and subtopics.

5 Other objects of the invention will, in part, be obvious, and, in part, be shown from the following description of the systems and methods shown herein.

Brief Description of the Drawings

10 The foregoing and other objects and advantages of the invention will be appreciated more fully from the following further description thereof, with reference to the accompanying drawing wherein;

Figure 1 depicts a screen shot of a portion of a orthogonal corpus and a set of documents and the scores associated with those documents.

15 Figures 2A through 2B depict a dataflow diagram of one process according to the invention for processing a body of reference material for organizing a collection of documents according to a hierarchical arrangement of topics provided by the reference material;

Figure 3 depicts one flow chart diagram of a process according to the invention;

Figure 4 depicts one system according to the invention; and

20 Figures 5-9 depict a further practice according to the invention organizing content according to indices generated from a plurality of references.

Detailed Description of the Illustrated Embodiments

25 To provide an overall understanding of the invention, certain illustrative embodiments will now be described. However, it will be understood by one of ordinary skill in the art that the systems and methods described herein can be adapted and modified to provide systems and methods suitable for other applications and that other additions and modifications can be made to the illustrated embodiments without
30 departing from the scope hereof.

It is a realization of the invention that the indexing and cataloging of content on the Internet, as well as from other stores of information, may be performed by applying a process that employs an orthogonal corpus, or corpora, of information, such as an
35 Encyclopedia. To this end, the processes described herein identify the topics discussed

5 within the corpus. The process also identifies within the corpus a set of keywords that are relevant to the topics presented in the corpus. The keywords associated with a topic may be employed to identify documents stored in another database that are related to the topic. A graphical representation of the index of topics found in the corpus may then be generated, with individual topics operating as links to these related documents. Thus, a
10 user interested in reviewing content in the corpus related to a certain topic, may also activate a link in the graphical representation of the index to access other documents that have been identified as related to the topic of interest to the user.

Turning to Fig. 1, there is depicted a graphical user interface 10 of the type
15 created and employed by systems according to the invention. The graphical user interface 10 represents a topic index 12, a portion of which is shown in this illustration. The topic index 12 may be a graphical representation of the table of contents of an encyclopedia, or other corpus. A user may employ the graphic interface 10 to access information that relates to the different topics listed in the index 12. Additionally, the
20 depicted index 12 includes topics and subtopics, including subtopics of the same ancestor topic. For example, in Fig. 1, the topic Human Origins is the ancestor topic for the subtopics, The Study of Ancient Human and the Distribution of Early Hominids. A topic, or a subtopic, may be understood to include, optionally, its ancestor topics or underlying subtopics.

25 The graphical representation of the index 12 may include a hypertext link, or other linking mechanism, for each topic or subtopic in the index 12. For example, the user may activate the links, as depicted by the highlighted topic PHYSICS in Fig. 1, to retrieve a group of documents having content that is associated with the selected topic. As further depicted by Fig. 1, the system 10 may provide a display 20 such that for a
30 selected topic or a subtopic, such as the selected topic Physics, a document 18, or a plurality of documents 18, may be presented to the user as documents associated with the topic. In the depicted embodiment, a pointer to the document, such as the title and URL 14 may be presented to the user. Additionally, an associated numerical score 16,
35 that represents that document's association to the topic may also be presented. The

5 development of such scores 16 will be described in more detail hereinafter. Optionally,
all the documents associated with a topic may be displayed in a window 20 of the
system 10.

Turning now to Figures 2A and 2B, dataflow diagrams are presented that
10 illustrate one process for creating a graphical interface, such as the interface 10 of Fig. 1.
Specifically, Figures 2A and 2B depict a process 30 wherein a corpus, such as an
existing published book of reference material, is processed by an orthogonal corpus
indexing (OCI) process that extracts content signatures and topic indices from the
corpus' content. The depicted process employs the content signatures to generate search
15 strings for search engines to identify content associated with topics described in the
corpus. The retrieved or discovered documents may be examined for content relevance
and the relevant documents may be associated with topics presented in the orthogonal
index of the corpus. Optionally, site attributes such as document type, timeliness, source
and other such attributes may also be identified and employed to select relevant websites
20 that may be associated with a topic in the index of the orthogonal corpus.

More specifically Fig. 2A depicts that the process 30 operates on a corpus 32 that
may be input to the index generator 34. The index generator 34 may generate an index
for the corpus 32 and this index may be provided to the keyword generator 48. The
25 keyword generator 48 may produce a set of key words 52 and may be associated with
the index 40. The process 30 continues in Figure 2B which shows the index 40 in the
search keys 52 being applied to a search engine 54. The search engine 54 discovers
documents from a database of content, or from a collection of databases of content 58 to
thereby create an association between at least one of the topics of the index 40 and the
30 information retrieved from the database 58.

The depicted corpus 32 may be any collection of information and may include,
but is not limited to, encyclopedias, text books, dictionaries, thesauruses, atlases, maps,
and other reference material. In one embodiment, the corpus 32 may be a published
35 book that may be turned into or stored in an electronic format such as a conventional

5 computer datafile of text information. The corpus 32, preferably in an electronic format, may be provided to the index generator 34. The index generator 34 may process the corpus 32 to identify a hierarchical organization of a plurality of topics that appear within the corpus 32. To this end, the index generator 34 may decompose the corpus 32 to create a standard hierarchical topic orientation that is capable of assigning text content to title, headers, topics, subtopics, or any other device that may be employed for representing a section of text related to a topic, meaning, category, or some other similar abstraction.

15 US Patent 5,963,203 entitled "*Automatic index creation for a word processor*" issued to Sotomayor, Bernard, describes methods that may be employed by the index generator 34. For example, Sotomayor describes methods that enable scanning one or more documents to automatically identify key topics and phrases in a document's text, as well as methods to generate an index to those key topics. Similarly, US Patent 5,819,258 entitled "Method and apparatus for automatically generating hierarchical categories from large document collections", by Vaithyanathan, Shivakumar, Travis, Robert, and Prakash, Mayank, further describes techniques that may be employed by the index generator 34 for determining an index for a corpus. Other techniques known in the art may also be employed by the index generator 34 without departing from the invention.

25 In an alternative practice, the index generator 34 allows an operator to identify the type of corpus 32 being input into the index generator 34. For example, the index generator 34 may present an interface to the operator that allows the operator to identify whether the corpus being presented comprises an encyclopedia, a dictionary, a textbook, or another known type of reference document. Additionally, the index generator 34 may allow the operator to identify whether the corpus 32 includes a table of contents, an index, chapter heading, or any other representation of the different topics contained within the corpus. In this embodiment, the user may identify, for example, that the corpus 32 comprises an encyclopedia and that the encyclopedia includes a table of contents that is representative of the index of orthogonal topics maintained within the

5 encyclopedia. In this embodiment, the index generator 34 may process the presented
corpus 32 to identify the table of contents for the encyclopedia. This table of contents,
in one embodiment, may be formatted into an HTML document that presents the table of
contents in an organized format that emphasizes the topics, subtopics and other
10 hierarchical structure of the table of contents. In one process the index generator 34
processes the notation for the table of contents, such as the topic numbering employed,
to identify which topics are understood as parent topics and which are understood as
main topics and which are understood as subtopics. In a further optional embodiment,
the index generator 34 may present the generated index with the orthogonal corpus 40 to
15 the operator to allow the operator to edit or amend the generated index for the
orthogonal corpus 40.

As shown in Figure 3B once the index generator 34 has processed the corpus 32
the index generator 34 may present the index 40 for the corpus 32 to the keyword
generator 34. As depicted in Figure 2A, the index 40 may comprise a hierarchical
20 representation of the orthogonal topics maintained within the corpus 32. This
hierarchical representation may include primary topics, such as the depicted topic 38 and
a plurality of subtopics 42 that are associated with the primary topic 38.

The keyword generator 48 in one embodiment operates to identify sections of text
25 of the corpus 32 to be associated with the different topics and subtopics of the index 40.
Continuing with the above example, in those practices where the index 40 is generated
from the table of contents for the corpus 32, the keyword generator 48 may identify
those pages that contain information associated with a topic presented within the index
40. For example, the keyword generator 48 may process the table of content for the
30 corpus 32 to identify a page number associated with a topic, such as the topic 40 and
may analyze the page associated with topic 40 to identify that portion of the page that
may be associated with the topic 40. In one embodiment, where headings are presented
within the corpus 32, the keyword generator 48 may analyze the page associated with
the topic 40 to identify a heading that is representative of the beginning of the
35 presentation within the corpus 32 of information that is associated with topic 40. For

5 example, the keyword generator 48 may identify a section of text within the associated
page that contains the information associated with topic 40 and that is presented in a
type font and font size that is representative of a heading. In a subsequent step the
keyword generator 48 may identify the location of the heading for the subsequent topic
10 44 that indicates the beginning of content related to the new topic. The keyword
generator 48 may identify the content that is delimited by the heading 40 and 44 and
associate that content as content related to the topic 40.

Once the portion of the corpus 32 that is to be associated with the topic 40 is
identified, the keyword generator 48 may process this assigned portion of text to
15 generate a plurality of search keys, each of which may be representative of a search
string for selecting information from a database.

In one embodiment, the system 10 employs the orthogonal construction of the
corpus for algorithmic identification of keywords in each topic that distinguish that topic
20 from its sibling, cousin, ancestor, or descendent topics. Accordingly, the systems
described herein may create a set of keywords for a topic that identifies a document
associated with a topic and that are keywords which may act to distinguish documents
associated with one topic, from documents associated with another topic. For example,
the system 10 may employ processes that identify keywords that are associated strongly
25 with a particular topic. Techniques for creating keywords will be understood from
Deerwester, S., Dumais, S.T., Landauer, T.K. Furnas, G.W. and Harshman, R.A. (1990),
"Indexing by latent semantic analysis." *Journal of the Society for Information Science*,
41(6), 391-407. Additionally, the system 10 may identify other keywords that act to
disassociate a document from one or more other topics. These keywords may be
30 employed by the system 10 to numerically score over an underlying pool of documents.

The system 10 may employ scoring methods that may utilize traditional
information retrieval techniques including the use of synonyms, stemming, frequency,
proximity, stop words, hyponyms, and synonyms. If, as in most large document
35 collections, it is not practical for all documents to be individually scored against the

5 keywords, then a subset of search words is selected to identify candidate documents for scoring. Keyword and search terms are identified based on a numerical method that apportions words among topics. The goal is for the keywords and search terms to identify individual blocks of text as found at the nodes of the orthogonal corpus topic hierarchy. In an ideal sense, the keywords would be partitioned across the hierarchical tree nodes, with each word occurring in only one corpus topic. In addition to word rarity among corpus topics, rarity in the underlying document pool may contribute to a word being identified as a keyword or search term for a given topic. For example, a keyword occurring in only one node and only once on the Web, would be a top candidate as a keyword and search term.

15 The keyword generator 48 may present as an output, a set of keywords 52 each of which may be associated with a topic or subtopic in the index 40. As described above, these keywords may be employed to act to distinguish documents associated with one topic from documents associated with another topic. Accordingly, as depicted in Figure 2B the search keys 52 and associated topics on the index 40 may be presented to the search engine 54 for retrieving information from a database or databases of content 58. To this end, the process 30 applies the search keys to the database 58 to retrieve information from the database 58. In one practice as will be described in more detail hereinafter, an optional step in process 30 is performed wherein the search keys 52 are processed to identify a subset of search keys that may be employed for generating search queries to one or more search engines, such as Internet search engines, to discover a set of documents which are relevant to the topic of interest. Each of the resulting documents may be examined in a subsequent step to determine the relevance of the content contained within the index. The relevance may be scored, as further described below, for identifying the relevance of that document, and the score may be employed for ordering the sequence in which content is listed as being relevant to a particular document.

30 Once the discovered documents are scored for relevance, the process 30 may associate portions of the discovered documents to associated topics within the index 38.

5 In a practice wherein the database 58 includes links to URL's for websites, the process
30 may create a web database that contains website information such as URL's, types,
dates, topics, contents, size and editor notes that are inserted or updated in the database
from time to time. Information about the corpus 32 that has been processed, such as the
10 publisher, the ISBN, and other types of information needed to purchase the book through
an online transaction may also be stored. The search engine may then provide a
navigation tool that comprises the HTML representation of the index 38 wherein topics
and subtopics within the index 38 link to URL's of web content identified as being
related to the topic or subtopic selected by the user. Optionally, in certain embodiments,
15 the topics and subtopics may also include links to portions of the corpus 32 that are
related to the topic selected by the user. In this way, a user may select a topic presented
by the corpus 32 in view of the information presented by the corpus 32 and related
information stored on the World Wide Web. In other embodiments, other techniques are
employed for semantic processing and for determining a topic that may be associated
with a portion of text within the corpus.

20 The data flow diagram depicted in Figs. 2A and 2B may be implemented in a
data processing process wherein a data processing program processes the corpus and
generates an index that links topics in the corpus to information from a data sources,
such as the Internet. Turning now to Fig. 3, a flow chart illustration of one such process
25 is depicted. Specifically, Fig. 3 depicts a process 70 for extending a corpus by
identifying topics covered by that corpus and employing information stored in the
corpus and related to the topics to identify information in a database that is also related
to the topic. The process 70 also generates an optional graphical user interface, such as
the interface depicted in Fig. 1, that includes links for topics listed in the index, and that
30 may be employed by a user to access the information associated with the listed topics.

The process 70 begins with the act 72 of identifying a corpus that is to be
extended, such as by selecting a publication that contains reference material. In step 72,
the process 70 transforms, or casts, the corpus into a normal form for processing. In one
35 practice, this involves decomposing the document format of the corpus into a standard

5 hierarchical topic orientation with a mechanism for assigning text content to title, headers, topics, and sub-topics. Optionally, stop words, such as the common words "and", "them", and "within", are identifies and removed during normalization.

10 After normalization, the process 70 proceeds to step 78 wherein the corpus is processed to identify which portions of the corpus relate to which topic. In one practice wherein the corpus includes a table of contents, the process 70 analyzes the document format of the corpus to locate within the text headings associated with the different topics. For example, as described in the above cited publication US Patent 5,963,203 entitled "*Automatic index creation for a word processor*", header information set off by
15 HTML tags may be identified to find indicia of topic entries in the document being processed. However, any technique for processing a document to identify the sections of text related to a topic may be applied, including other techniques for analyzing the mark up form language of the document.

20 Proceeding to step 80, the process 70 analyzes the topics to identify a signature that may be understood as representative of the semantics of the topic. In one practice, the process 70 creates a word map per topic and subtopic. To this end the process 70 in step 80 may create a summary representation of the words in the text based on the number of, location of, and proximity of words within each topic and sub-topic. Other
25 factors may be employed, or substituted for these. Statistics are maintained on different parts of the document structure such as titles, headings, paragraphs, sentences, and image.

30 Table I depicts that several topics may be identified within the corpus. For example, Table I depicts that the processed corpus includes the topics Archaeology, Argentina, Arithmetic, Art, and Astronomy.

<u>Topic</u>
Archaeology

Argentina

Arithmetic

Art

Astronomy

TABLE I

The process 70 in one practice may then determine for a given topic, the word count for the words that appear within the portion of text, or other content, associated with the respective topic. This is depicted in Table II, that shows an example of the word count, with stop words removed, for words that appear in the portion of the corpus related to the topic "Astronomy."

Word counts in Topic Astronomy

Word	Count
actual	1
ad	1
adopted	1
advances	2
ancient	3
application	2
assigning	1
astronomer	2
astronomers	2
astronomical	5
Astronomy	12
astronomy	11
Astrophysicists	1
astrophysics	1

TABLE II

In process 70, after the word count, and other statistics are determined, signatures are generated using orthogonalization. For example, in one practice, given the word counts or word maps for all or a selected subset of topics simultaneously, the process 70

5 assigns a weight based on word count to each word within each topic or subtopic.
Where using word counts the weight may be defined as the count. When using the word
map, the weight of a word in a topic or subtopic may be assigned by an intra-document
scoring function. Any suitable technique may be employed for performing intra-
document scoring. These signatures may be edited or cleaned manually to enhance the
10 topical relevance and precision of the subsequent search and scoring process. Table III
depicts an example signature for the topic "Astronomy."

Signature for topic Astronomy	
Word	Count
Astronomy	23
earth	9
bodies	5
Astronomical	5
universe	4
celestial	3
circle	3
Observational	3
sky	3
Stars	3
Ancient	3
Daily	3
Heavenly	2
Astronomers	2
planet	2
relative	2
moved	2
heavens	2

TABLE III

35 After determining a signature, the process 70 may perform the optional step, step
82, of applying synonym Groups. In this optional step, the process 70 extends the

signatures with synonym groups. To this end, words are replaced by groups of word substitutes having similar or identical meaning. Table IV depicts such an extension.

Astronomy Signature Post Synonym Reduction	
Word	Count
Astronom	30
earth	9
bodies	5
universe	4
celestial	3
circle	3
Observational	3
sky	3
stars	3
ancient	3
daily	3
Heavenly	2
planet	2
relative	2
moved	2
heavens	2

TABLE IV

After step 82, the process 70 may proceed to step 84, wherein the process reduces the signature to Keyword sets, optionally tailored for the search. The set of documents to be scored against a topic is preferably identified and manageable in size. The web for example is a large a document set to collect up and score against all web documents. Accordingly, in one practice traditional large scale search engines, such a Lycos and Alta Vista, may be used to identify a set of candidate relevant documents using a keyword set for search. Which subset of the Signature and synonym groups is included in the Keyword set may be determined based on a variety of measures

5 including corpus document word count of the word and general frequency of the word.
An example is presented in TABLE V.

Word	Count
Astronomy	30
Earth	9
Bodies	5
Universe	4
Celestial	3
Circle	3
Observational	3
Sky	3
Stars	3
Ancient	3
Daily	3

20 **TABLE V**

25 The keyword set may be applied to a search mechanism to pull in multiple
discovered documents based on the keyword set. This may occur in step 88. For
example, the query Find: Astronomy or Astronomical or Astronomers or earth or bodies
or universe or celestial or circle or Observational or sky or stars or ancient or daily; may
be generated from the keyword set and applied to the search mechanism to discover
documents related to the selected topic.

30 After the step 88, the process 70 may proceed to step 90 for scoring of the
discovered documents. The many discovered documents returned from a search
function may be assigned individual scores against the corresponding corpus topics and
subtopics. Scoring may be based on multiple tunable metrics and rules including
35 functions over the word count or word_map data structures. The score of topical overlap
between two documents as a baseline is measured as a dot product of word counts or
word frequencies within those documents).

Scoring example

Word	Count in Astronomy	Count in discovered document	Score Contribution
Astronom	30	2	0.555556
earth	9	1	0.083333
bodies	5		
universe	4	5	0.185185
celestial	3		
circle	3	2	0.055556
Observational	3		
sky	3		
stars	3		
ancient	3	1	0.027778
daily	3	2	0.055556
Heavenly	2		
planet	2		
relative	2		
moved	2	1	0.018519
heavens	2	1	0.018519

After step 90, the process 70 proceeds to optional step 92, wherein the topic hierarchy and set of associated documents may be presented directly through an HTML or graphical user interface, such as the interface depicted in Fig. 1. Alternatively, content may be delivered through software API's (application program interfaces) to allow integration of output content with other content. Content may be navigated by walking the directory tree structure, or by keyword searching over the directory structure trees, corpus content, or discovered document content. Search results may point to topic paths or discovered documents,

Fig. 4 depicts one embodiment of the system 100 according to the invention. Specifically Figure 4 depicts a functional block diagram that shows a system 100 that allows a surfer 102 to access a user interface 104 that couples to a database system 108. The database system 108 further couples to an OCI processor 112 that accesses a database of corpora 114 and a plurality of search engines 118. The database system 108 further couples to an application programming interface access layer 120 and through the API 120 can access a portal/search client 122. Additionally, the API 120 may also couple to a scoring mechanism 124.

5 More particularly, Figure 4 depicts that a user 102 such as an Internet user may access a user interface 104, that may be similar to the user interface depicted in Figure 1. As shown in Figure 1 the user interface 10 may present to the user 102 a list of topics 112. The user 102 may select a topic from the index 112. As described with reference to Figure 1, the selection of a link directs the user interface 104 to retrieve information from the database system 108. The database system 108 processes the users request from user 102 for information related to the selected topic.

15 The database system 108 may be any suitable database system, including the commercially available Microsoft Access database, and can be a local or distributed database system. The design and development of suitable database systems are described in McGovern et al., *A Guide To Sybase and SQL Server*, Addison-Wesley (1993). The database 108 can be supported by any suitable persistent data memory, such as a hard disk drive, RAID system, tape drive system, floppy diskette, or any other suitable system.

20 As further depicted by Figure 4 that database system 108 may communicate with the OCI mechanism 112. The OCI mechanism 112 may be, in one embodiment, a computer process capable of implementing a process such as process 70 depicted in Figure 3. The OCI mechanism can be realized as a software component operating on a conventional data processing system such as a Unix workstation. In that embodiment, the OCI mechanism can be implemented as a C language computer program, or a computer program written in any high level language including C++, Fortran, Java or basic. Techniques for high level programming are known, and set forth in, for example, Stephen G. Kochan, *Programming in C*, Hayden Publishing (1983). Accordingly, the OCI mechanism 112 may be employed by a system administrator to process corpora stored within the database 114. As discussed with reference to Figure 3, the processed corpora results in a graphical user interface that may be stored within the database mechanism 108 and accessed by the user 102 through the topic navigator 104. Additionally, the OCI mechanism 112 may generate for the processed corpora of database 114 a set of links or pointers to content that corresponds with different listed

5 topics within the index of the processed corpora. The OCI mechanism 112 may also store these associated links within the database system 108.

10 To this end, the OCI mechanism 112 may couple to one or more search engines 118 that allow the OCI mechanism 112 to retrieve content from a database source. In the depicted embodiment of Figure 4, the database source that search engines 118 access is the World Wide Web 106. In this embodiment, the user interface 104 also couples to the World Wide Web 106 so that links activated by the user that relate to URL's of content stored on the World Wide Web 106 may be directly accessed by the user 102 through the user interface 104 through the connection between the user interface 104 and the World Wide Web 106. Figure 4 further depicts that the database 108 communicated with an API layer 120. As shown in Figure 4 the API layer sits between the portal search client 122 and the database system 108 and also sits between the scoring mechanism 124 and the database system 108. Accordingly, a portal search client such as the Yahoo site may access the database system 108 through the API layer to provide users with access to an index linked to content on the World Wide Web.

25 Similarly, Figure 4 depicts the scoring mechanism 124. The scoring mechanism 124 may be a computer process that accesses the database system 108 through the API 120. The scoring mechanism may perform data mining for identifying topics that are to be associated with different websites. In this way, the database system 108 may be employed for categorizing web sites according to their content. Thus, the system 100 depicted in Figure 4 provides a system for categorizing information stored on the World Wide Web. The system described in Fig. 4 may operate on any suitable computer hardware, such as PC compatible computer systems, Sun workstations, or any other suitable hardware. The list of topics and the associated documents, or links to documents may then be stored in a relational database, or any suitable database with proper indexing for allowing rapid accessing of the data stored therein.

5 Once the system is operating, the system may be employed to provide a set of tools, such as that may operate as stand alone applications for single users, or that may be tools provided as client/server programs over a network. The tools may be provided as a collection of functions incorporated into an integrated research tool, or may co-exist as individual functions in a separate application.

10 Further embodiment, the systems and methods described herein may be employed for organizing a plurality of corpora into an indexed format that may be presented as a graphical user interface for a user to allow a user to access information related to the contents of a plurality of corpora. For example, figures 5 through 9 depict
15 the operation of a system that processes a plurality of text, such as reference texts. Accordingly, the system may be employed for the automatic creation of a topically organized book catalog, such as a catalog of reference books, with navigation, search, click through to external documents such as web documents, with information purchasing interfaces also. For example, figure 5 depicts a graphical user interface that
20 presents to a user a plurality of topics each having a set of books within the topic. For example, the figure 5 depicts a topic reference that includes a set of encyclopedias and dictionaries within that reference. By activating the reference link, the user may be presented with the user interface shown in figure 6. Figure 6, the individual references presented under the reference topic of figure 5 are outlined for the user allowing the user
25 to select what type of reference the user would like to view.

 For example, the user may select from encyclopedias, dictionaries, academic and learned society publications and other such publications. After making a selection
figure 6, the user may be presented with the different books under each category. The
30 example presented in figures 5 through 9 shows that upon activating the link for encyclopedias, the user is presented with the different encyclopedias that have been processed by the system according to the invention. Upon selecting a link, such as the link for the Encyclopedia Britannica, the user may be presented with the interface shown in figure 8 that lists the different topics covered by the Encyclopedia Britannica. At this
35 level, the process now proceeds as described above, with reference to figures 1 through 4

5 wherein the individual topics maintained within the Encyclopedia Britannica may be employed for accessing contact, such as web contact particularly associated with the individual topics.

10 Those skilled in the art will know or be able to ascertain using no more than routine experimentation, many equivalents to the embodiments and practices described herein. For example, the systems and methods described herein may be employed for providing encyclopedia (i.e., corpus) extender. An encyclopedia (as an archetype example of an orthogonal corpus) may be automatically extended by application of the systems and methods described above, to include links into the World Wide Web, or
15 other database, via searching or meta-searching over the Web. The breadth and depth of the corpus enables a high quality, high coverage database of web links, with the web links organized according to the location in the topic hierarchy whose text was used to generate them. Such links may provide geographical maps, histories of topics of interest, access to theses and other types of information. Other applications include
20 web book companions wherein the system processes a book, including a fictional work, a non-fictional work, or a reference book, through this system will allow automated construction of topical web sites as Web Companions to individual books. For example, a book such as the Hunt for Red October may be processed by the systems described herein to create links into the Web to documents associated with concepts from the
25 book, such as links to the Navy Submarine division, links to topographic maps of the ocean floor, links to Russian Naval History, and other similar links.

A search engine extension may be provided by accessing the database 108 through the API. Thus a user may do a search on a web search engine, they may want to
30 refine their search or get a second search opinion. Given a broad topic database such as that created in the Encyclopedia Extender application described above, refinement of a user's intended topic is enabled – through keyword-based narrowing, web link browsing, and display of proximal or correlated topics in the corpus topic hierarchy. For e-commerce, the systems described herein book/article browser/seller. Browsing over the
35 topic hierarchy may provide indexes into books or articles for sale.

5 Additional applications can include a user Interface. The user interface allows users to view Web links through the topic hierarchies defined by the corpus. The topic hierarchy on the left lists the topics as per the corpus. The user may select keywords from the corpus outline, or from provided sample text inside the corpus documents, to better focus and score the topic. Users may augment the search terms or keywords with their own keywords or selected synonyms to more specifically tailor a concept to a need. Searching across the corpus or across the referenced links may include synonyms, stemming, frequency, proximity, stop words, hyponyms, and synonyms.

10 Additionally, authoring toolkits may be provided that allow publishers, editors, and authors to create corpus extensions and associated applications. For example, the systems and methods described herein may be employed to create development kits that publishers may use to index a book and create a web site that acts as the book companion described above.

15 It may be noted that human oversight or auditing of the document scoring and database may be done in order to augment the purely automated document selection. This may be done on a sampling basis for quality control. Different levels of sensitivity to content or product price points may be implied by different levels of human quality control. Moreover, it will be noted that the system described above has been done so with reference to documents stored on the Web. However, it will be understood by those of ordinary skill in the art, that the Web is being used here as a metaphor for any electronic document archive, and the systems and methods described herein are not limited to the Web.

20 Accordingly, it will be understood that the invention is not to be limited to the embodiments disclosed herein, that other applications, such as information mining may be practiced with the systems and methods described herein, and that the invention is to be understood by the following claims which are to be interpreted as broadly as allowed under the law.

We claim:

1. A method for processing a body of reference material to generate a directory for
accessing information from a database, comprising
processing the body of reference material to identify a hierarchical organization
of a plurality of topics,
associating with at least one of said topics a portion of the reference material,
processing said assigned portion of the reference material to generate a plurality
of search keys representative of search strings for selecting information from the
database,
applying the search keys to the database to retrieve information from the
database, and
creating an association between the at least one topic and the information
retrieved from the database.
2. A method according to claim 1, further comprising
creating a graphical interface representative of the identified hierarchical
organization of a plurality of topics for allowing a user to access information retrieved
from the database and having an association with a topic.
3. A method according to claim 1, wherein processing the body of reference
material includes processing a body of reference material selected from the group
consisting of an encyclopedia, a dictionary, a text book, a novel, a newspaper, a
web site, and [Henry what else are we interested in processing?].
4. A method according to claim 1, wherein processing the body of reference
material includes processing the body of reference material to identify a
hierarchical organization of a plurality of substantially orthogonal topics.
5. A method according to claim 4, wherein processing the body of reference

5 material includes identifying a table of contents for the body of reference material.

6. A method according to claim 4, wherein processing the body of reference material includes identifying chapter headings.

10 7. A method according to claim 4, wherein processing the body of reference material includes identifying definition entries in a dictionary.

15 8. A method according to claim 4, wherein processing the body of reference material includes normalizing the identified hierarchical organization of a plurality of topics. [Henry - here we are interested in any things we do to process the hierarchical organization to make the topics more orthogonal].

20 9. A method according to claim 1, wherein processing the assigned text includes generating a word map representative of a statistical analysis of words contained in the assigned text.

25 10. A method according to claim 9, wherein generating the word map includes performing a word count process for determining word frequency of a word within the assigned text, and for employing the word frequency for determining relevance of a word to the associated topic.

30 11. A method according to claim 1, wherein processing the assigned text includes processing the assigned text to identify a set of keywords having an associated measure of intra document orthogonality.

12. A method according to claim 1, wherein processing the assigned text includes identifying a set of synonyms for extending the search keys.

35 13. A method according to claim 1, wherein processing the assigned text includes

5 selecting a subset of the search keys having a predetermined measure of correlation to the topic.

14. A method according to claim 1, wherein applying the search keys to the database includes applying the search keys to an Internet search engine to discover
10 documents related to the search keys.

15. A method according to claim 1, wherein applying the search keys to the database includes applying the search keys to a meta-search engine to discover
15 documents related to the search keys.

16. A method according to claims 14 or 15, wherein applying the search keys to the database includes processing text of the discovered documents to identify documents related to the topics associated with the search keys.

17. A method according to claim 1, wherein creating an association between the at least one topic and the information retrieved from the database includes capturing a location pointer associated with the information retrieved from the database.

18. A method according to claim 1, wherein creating an association between the at least one topic and the information retrieved from the database includes creating a data
25 structure for the topic for storing location pointers associated with information retrieved from the database.

19. A system for organizing a collection of documents, comprising
30 an orthogonal corpus of information arranged according to an index of topics,
 a keyword generator for generating a set of keywords representative of a document's association with a topic in the index of topics,
 a scoring system for processing documents within the collection of documents, to associate with at least a portion of the documents, a score representative of the
35 document's association to a particular topic, and

5 a graphical representation for depicting at least a portion of the index of topic and
having respective portions of the graphical representation linked to documents
associated with a respective portion of the index of topics.

20. A system for extending the content of a first document, comprising

10 a parser for selecting terms with said first document to be extended,
an orthogonal corpus of information arranged according to the index of topics,
a keyword generator for generating a set of keywords representative of a
document's association with a topic in the index of topics, and

15 a linking system for processing documents within a collection of documents, to
associate with at least a portion of the documents, a score representative of the
document's association to a particular topic, and for providing said first document with
links into said collection of documents for extending the content of said document.

1510

Corpus Navigator

File Edit View Options Help

Corpus Navigator and Administration

12

THE STUDY OF ANCIENT HUMANS

- 1. Estimating the Age of Finds
- 2. Distribution of Early Hominids
- Painting
- Philosophy
- Physics
- History
- Scientific Methods Used in Physics
- Galileo Found Modern Mechanics
- Newtonian and Relativistic Mechanics
- Old and New Concepts of Heat
- The Problem of Explaining Light
- Some Major Figures in Modern Physics

BIBLIOGRAPHY FOR PHYSICS

- Chemistry
- Bio Chemistry
- Physical Chemistry
- Flagel, Jean
- Philox
- Reproductive System

14

Score [10.4] Department of Physics, <http://www.boun.edu.tr/~yazoku/phys.html>

Score [9.5] Amazon.com: Table of Contents: Physics for Scientists and Engineers <http://www.amazon.com/exec/obidos/ts/book-contents/0134329805/qid=912039041/sr=1-11>

Score [9.0] PHYSICS Course Descriptions <http://kraken.mvnet.wnec.edu/~lchojnic/courses/ugrad/phys.htm>

Score [7.9] Physics 205 <http://www.wsu.edu/~jtd/Physics205/phys205.htm>

Score [7.6] PHYS102 Dynamics, Waves and Atoms <http://www.phys.canterbury.ac.nz/courses98/phys100/phys102.html>

Score [7.6] Syllabus for Physics 104 <http://alpha.centenary.edu/syllabus/sylph104.html>

Score [7.4] Amazon.com: Table of Contents: University Physics, Spreadsheets <http://www.amazon.com/exec/obidos/ts/book-contents/0471539546/>

Score [11.4] The Progress of Science (1887) <http://aleph0.clarku.edu/huxley/CE1/ProSci.html>

Score [11.2] ECTS Page - Faculty of Physics and Astronomy, Jena <http://www.physik.uni-jena.de/ects.html>

Score [11.1] The Space-Time Universe <http://www.randomc.com/~rs/Articles/SpaceTimeUniverse.html>

191

Solution update succeeded

STREAM

Ch1

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Col:1

Col:1

Col:1

Col:1

Col:1

Col:1

Col:1

Col:1

Col:1

Col:1

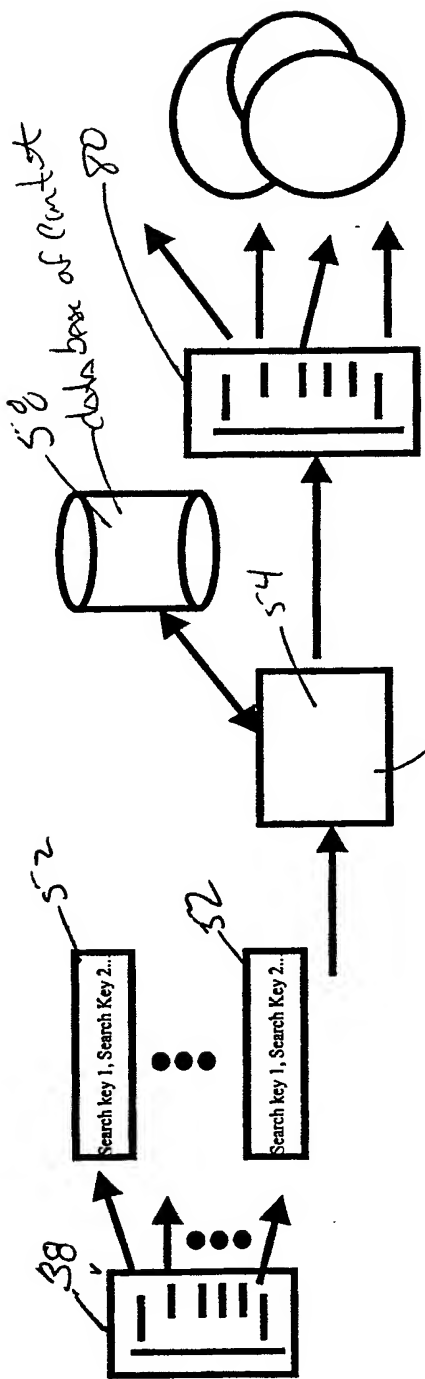
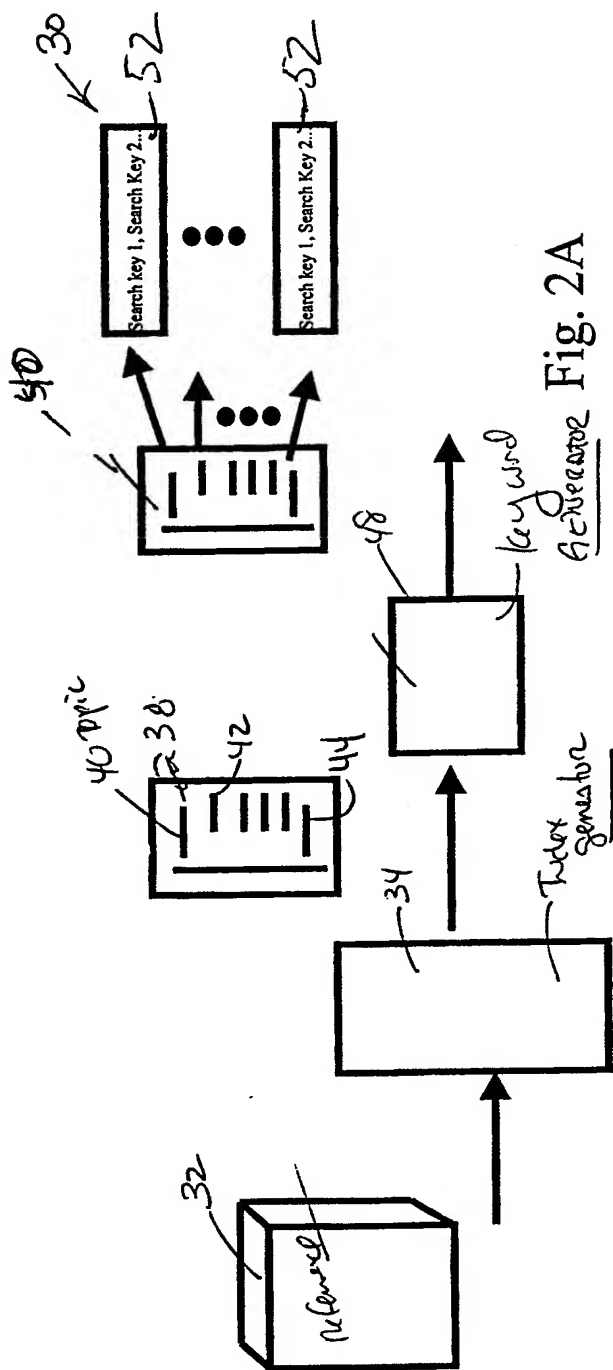
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Col:1



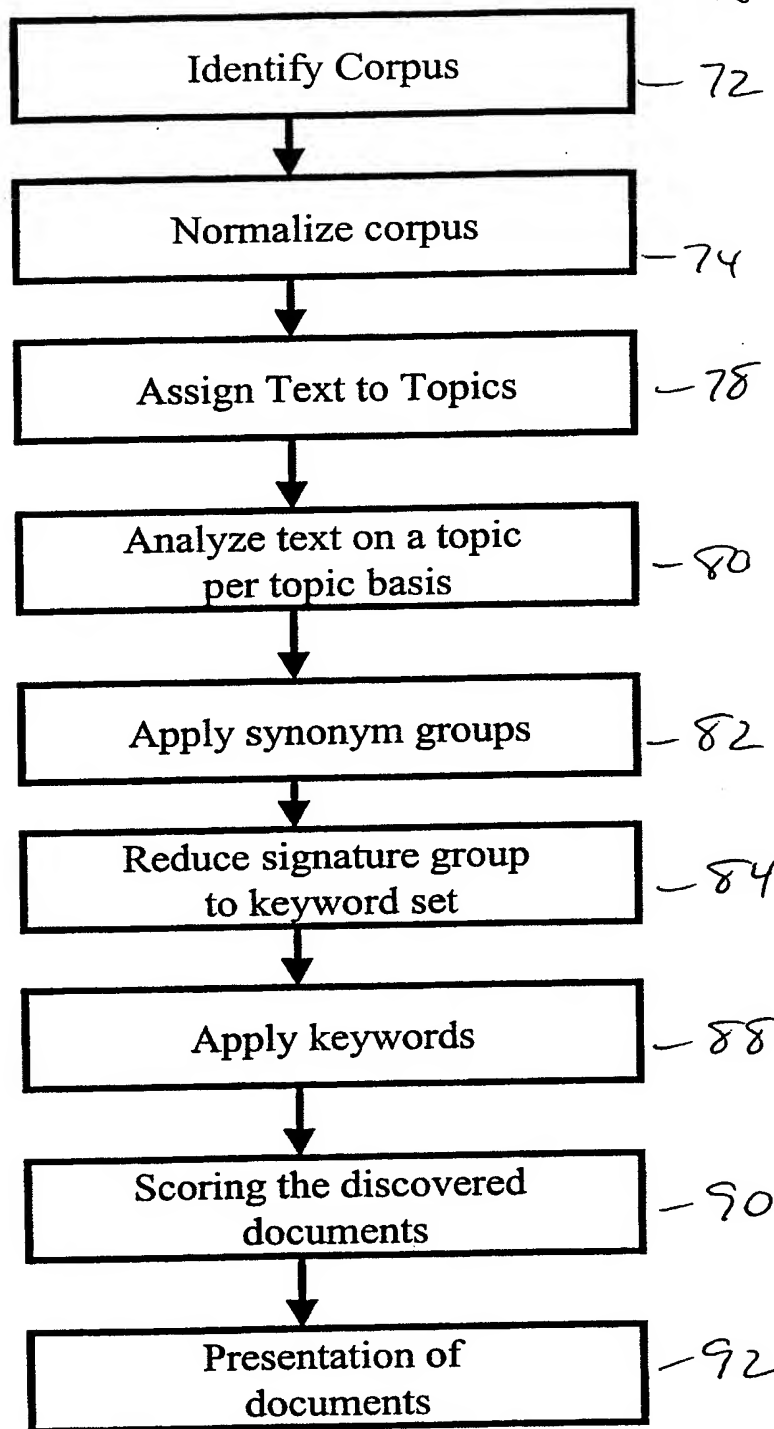


Fig. 3

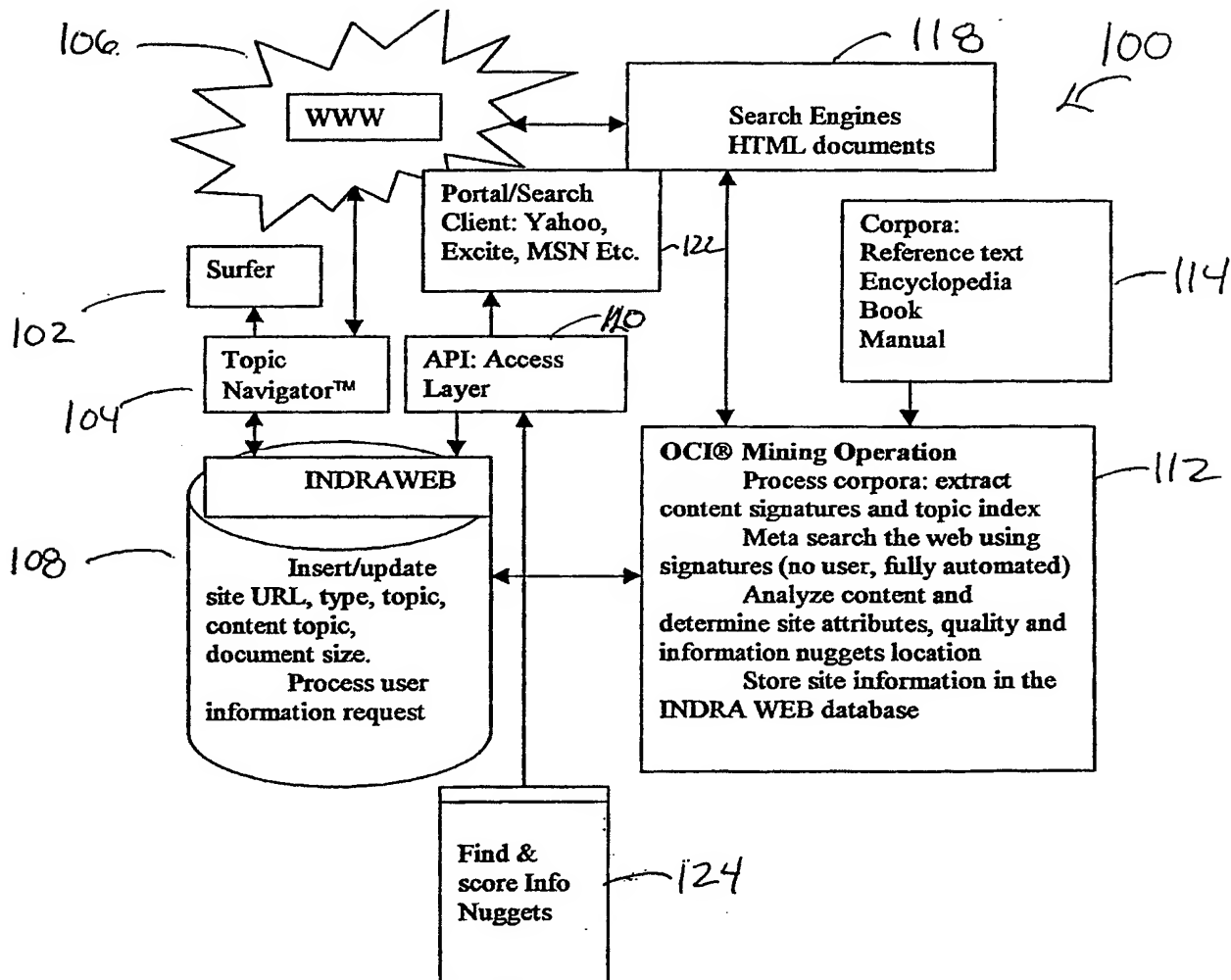
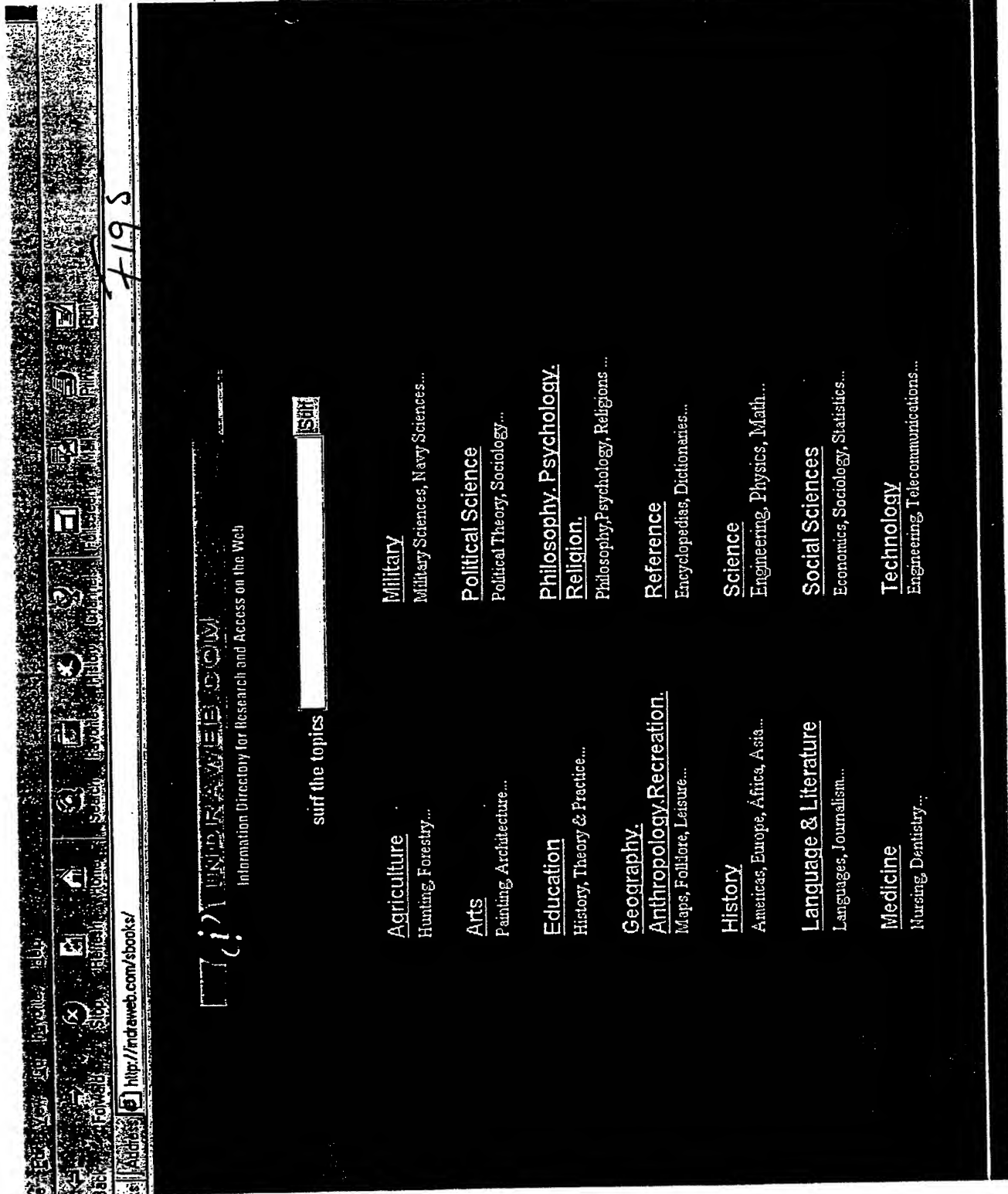
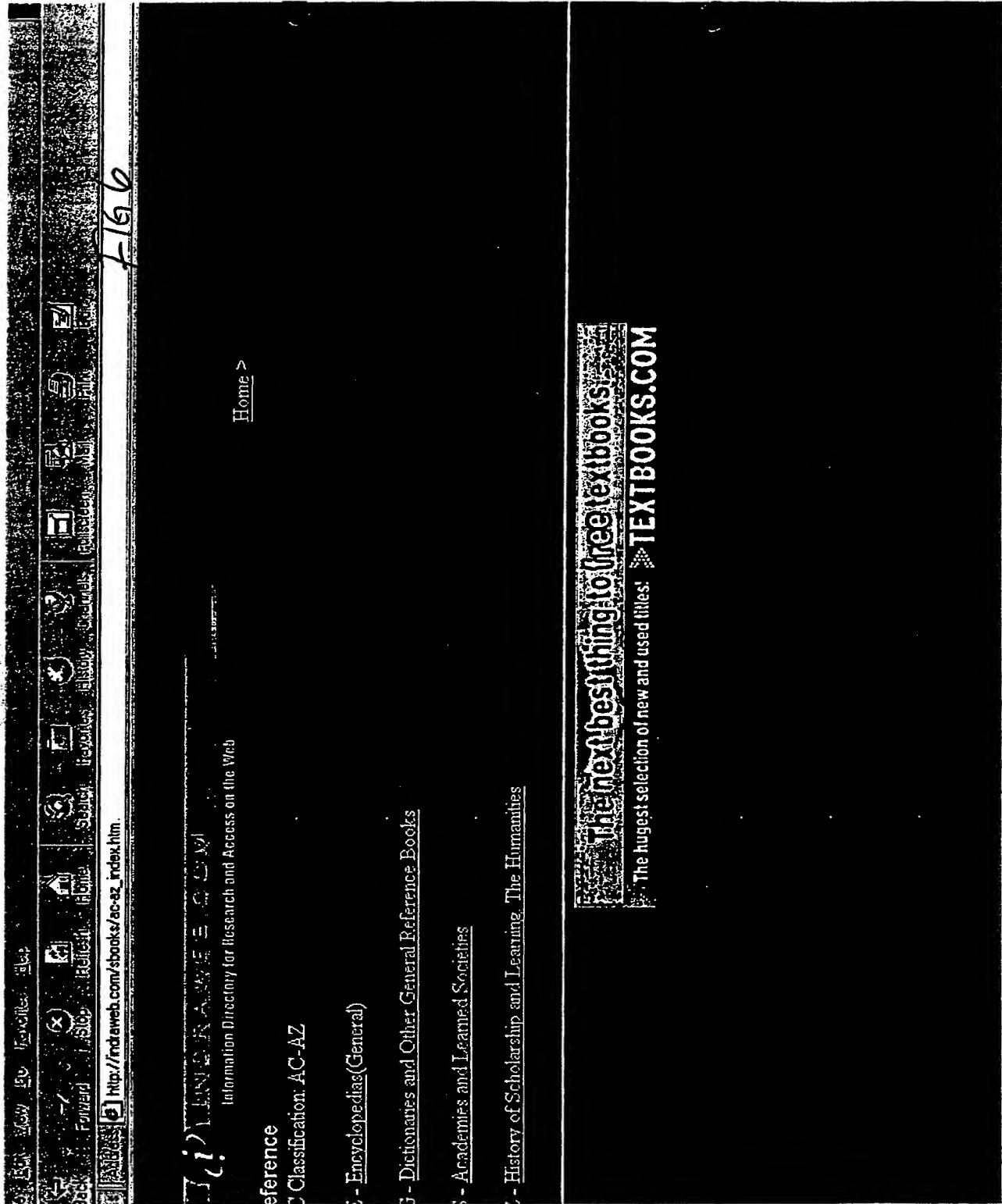


Fig. 4







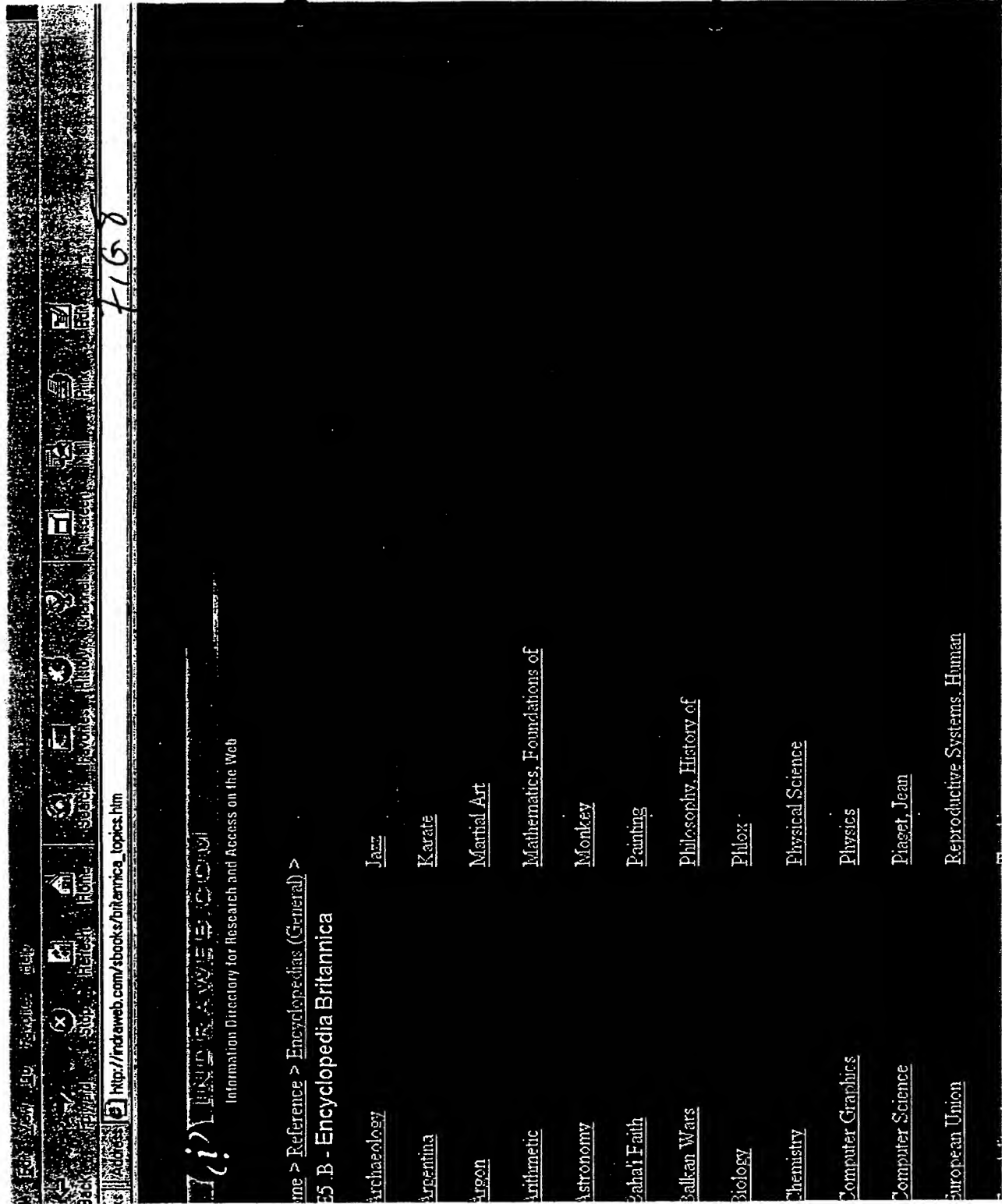
http://mc.manuscriptcentral.com/ae.htm

Home > Reference >

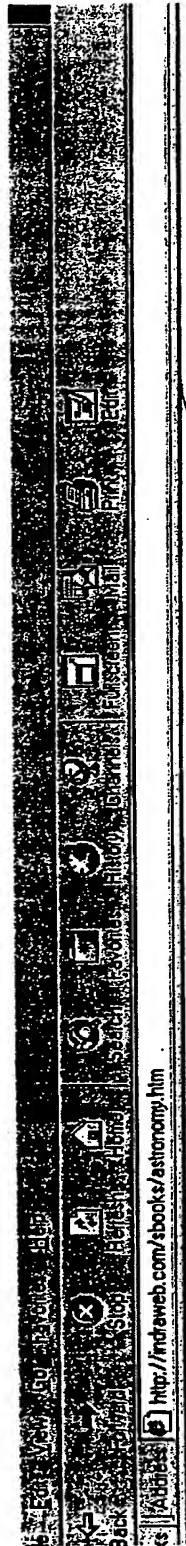
E - Encyclopedias (General)

Encyclopedia of universal knowledge : British Library MSS Royal 6 E VI-E VII	1996	AE2 L463 S26	H. Miller Publishers
Encyclopedia Americana encyclopedia.	1998	AE5 A23	Grolier Inc.
Encyclopedia Britannica	1997	AE5 B	Routledge
Encyclopedia of knowledge	1995	AE5 C36	Cambridge University Press
Encyclopedia of knowledge	1993	AE5 C36	Cambridge University Press
Encyclopedia of knowledge	1997	AE5 C683	Collier's
Encyclopedia Americana	1999	AE5 E333	Grolier Incorporated
Encyclopedia of knowledge	1991	AE5 E478	Grolier
Encyclopedia of knowledge	1997	AE5 F36	Oxford University Press
Encyclopedia of knowledge	1996	AE5 F83	Funk & Wagnalls
Encyclopedia of knowledge	1991	AE5 M24	Macmillan
Encyclopedia of knowledge	1993	AE5 M38	Macmillan Educational Co.
Encyclopedia of knowledge	1998	AE5 N64	Ferguson Pub. Co.
Encyclopedia of knowledge	1993	AE5 O94	Oxford University Press
Encyclopedia of knowledge	1992	AE5 W35	Merriam-Webster, Inc.
Encyclopedia of knowledge	1999	AE5 W55	World Book
Encyclopedia of knowledge	1998	AE5 W563	World Book

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ime > Reference > Encyclopedias (General) > Encyclopedia Britannica >

55.B Encyclopedia Britannica: Astronomy

astronomy earth bodies astronomical universe celestial circle observational sky stars ancient daily heavenly astronomers planet
 search: relative moved heavens ray ptolamaic copernicus revolution recognized electronic advances position rad (Any word)

und: 277 document(s) on The Web

Sort: Score

Imagine the Universal Dictionary

Please allow the whole page to load before you start searching for an entry. Otherwise, errors will occur. [A B C D E F G H I J K L M N O P Q R S T U V W X Y Z]

] A accretion Accumulation of dust ...

Found by: Infoseek, WebCrawler

<http://imagine.gsfc.nasa.gov/docs/dictionary.html>

APOD Glossary

Astronomy Picture of the Day Glossary Cepheid: A pulsating variable star. This type of star undergoes a rhythmic pulsation as indicated by its regular pattern of changing brightness as a function of time.

Found by: WebCrawler

<http://anbwp.gsfc.nasa.gov/apod/lib/glossary.html>

ASTRONOMY

In this page I've written something about. ASTRONOMY. Versión en Castellano. WE CAN ALWAYS LEARN SOMETHING NEW ! Astronomy is the science of heavenly ...

Found by: AltaVista

<http://www.geocities.com/Yosemite/Trials/7812/e-astronomia.html>

<http://chandra.hgsu.edu/~gcl/Spacetime6.html>

Back to the course home page. Back to Table of Contents. Chapter 6 The Transition from Aristotle to Newton I. Introduction The purpose of this chapter is to describe, in broad outlines, the contributions to the theory of space and time which were.

Found by: HotBot

<http://chandra.hgsu.edu/~gcl/Spacetime6.html>

Expanding Universe: Astronomy

520 : 525 - Astronomy and Allied Sciences. 520 522 523 525. General astronomy sites, periodicals, associations, planetariums Observatories, ...

Found by: AltaVista

<http://www.mtl.toronto.on.ca/cities/bst/astronomy/520-25.htm>

The Atheism of Astronomy

Historical Documents: Wnisev Teller Atheism Of Astronmy The Atheism Of Astronmy: A Refutation Of The Theory That The Universe Is Governed By

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PCT

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WO 00/62198 A2

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(30) Priority Data:
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(71) Applicant: **INDRAWEB.COM, INC.** [US/US]; P.O. Box 323, Concord, MA 01742 (US).

(72) Inventors: **KON, Henry**; 91 Bow Street, Lexington, MA 02420 (US). **BURCH, George**; P.O. Box 323, Concord, MA 01742 (US).

(74) Agents: **KELLY, Edward, J.** et al.; Foley, Hoag & Eliot, LLP, One Post Office Square, Boston, MA 02109 (US).

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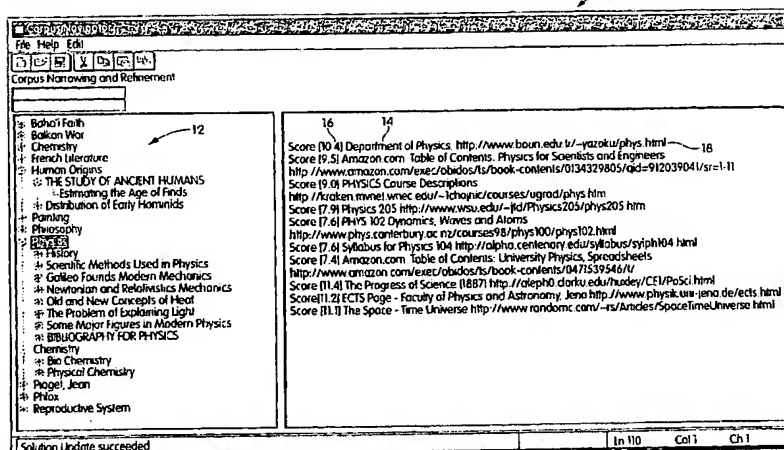
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(54) Title: **SYSTEMS AND METHODS FOR EMPLOYING AN ORTHOGONAL CORPUS FOR DOCUMENT INDEXING**



(57) **Abstract:** The invention provides for indexing and cataloging of content on the Internet, as well as from other stores of information, may be performed by applying a process that employs an orthogonal corpus, or corpora, of information, such as an Encyclopedia. To this end, the processes described herein identify the topics discussed within the corpus. The process also identifies within the corpus a set of keywords that are relevant to the topics presented in the corpus. The keywords associated with a topic may be employed to identify documents stored in another database that are related to the topic. A graphical representation of the index of topics found in the corpus may then be generated, with individual topics operating as links to these related documents. Thus, a user interested in reviewing content in the corpus related to a certain topic, may also activate a link in the graphical representation of the index to access other documents that have been identified as related to the topic of interest to the user.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

SYSTEMS AND METHODS FOR EMPLOYING AN ORTHOGONAL CORPUS FOR DOCUMENT INDEXING

Field of the Invention

The invention provides systems and methods for organizing a collection of information, such as a database of documents, and more particularly, to systems and methods for classifying information with respect to a set of independent concepts, and applications of the classified information.

Background of the Invention

The computer-based storage of information has become the norm for our knowledge-based society, and today huge databases of computer-stored information are available to researchers. For example, through the World Wide Web service, the Internet has become an enormous repository of readily accessible information. However, the sheer volume of information maintained on the World Wide Web becomes problematic when someone wishes to identify those resources, or documents that are maintained on the Internet and that are related to a certain topic. The problem is that a simple search request for information stored on the Internet and related to a certain topic returns an enormous volume of information, most of which is extraneous and irrelevant. This problem arises in part from the difficulty that existing Internet retrieval systems have with prioritizing and categorizing documents stored on the World Wide Web. Today, most systems for organizing content on the web work by searching through a document stored on the web, and associating with the document a set of key words that represent the information contained on the reviewed pages. Accordingly, documents can be organized according to the keywords that appear in the document.

5 However, lists of keyword, although helpful, lack an identifiable hierarchy of
concept and therefore fail to provide a topic-based system for organization and
document retrieval. Thus, keyword lists are less powerful tools for document research
than topic-based hierarchal systems of document organization, such as tables of content,
or topic indexes. Today there is a need for a "table of content" for the World Wide Web.
10 Such a table of content would provide a more powerful metaphor for using the Web as a
research tool and would provide a flexible platform on which other research tools could
be built. As such, there is a need for improved systems for organizing information
stored in a computer database, such as the World Wide Web.

15 Summary of the Invention

 The systems and methods described herein provide systems for document
indexing and scoring of content on a computer database, such as the World Wide Web.
The systems generally include an orthogonal corpus that may comprise a collection of
blocks of text, and that may be employed to index and score textual information for
20 applications in retrieving, classifying, or browsing over a set of documents.

 An orthogonal corpus, as the term is employed herein, may be understood to
encompass, without being limited to, any collection of blocks of text that are outlined or
referenced by a table of contents, topic index, chapter heading or other topical indicia
where each topic either stands alone or is an identified subpart (subtopic) of another
25 topic, forming a tree of topics and their descendant subtopics. Encyclopedias, text and
reference books, periodicals, web sites, dictionaries, thesauri, the library of congress, the
Dewey decimal system, and glossaries are examples of, surrogates for, or extenders of
orthogonal corpora. A set of topics is understood as orthogonal in the sense that
substantially every member topic (e.g., chapter or article) covers a different concept or
30 substantially different concept than any other topic under the same ancestor topic in the
tree. A topic in one practice may be assumed to include or not include, its ancestor
topics or underlying subtopics.

 The orthogonal construction, or decomposition, of a corpus provides for
algorithmic identification of keywords in each topic, which distinguish it from its
35 sibling, cousin, ancestor, or descendent topics. Keywords may be employed to

5 numerically score over an underlying pool of documents. Alternatively, if more practical for a given application, such as when working with a large document collection, rather than individually score all documents in the collection against the keywords, then a set of search words may be generated to identify a subset of candidate documents for scoring.

10 Parameters employed during the scoring process may relate to the identification of keywords and their refinement into a set of search words, with weightings for associated document or sub-document scoring. The scoring, search term, and keyword methods may employ conventional information retrieval techniques including the use of synonyms, stemming, frequency, proximity, stop words, hyponyms, and synonyms.

15 For purposes of clarity certain terms will now be described, although the understandings set forth are not to be understood as limiting and are only provided for purposes of achieving clarity by way of providing examples. The term "word" as employed herein may be understood to encompass a lexical type found in a common or specialty dictionary of any language. The term "phrase" as employed herein may be understood to encompass any sequence of one or more words. Heretofore for simplicity we use "Word" to mean "Word or Phrase." The term "synonym group" shall be understood to encompass a set of words which may be used as alternates for a given word. Each word in a synonym group has a similar or identical meaning. The term "topic" shall be understood to encompass textual content typically having a title, having
20 corresponding text, concerning a single topic, or covering a set or tree of related subtopics. The term "subtopic" shall be understood to encompass a block of text within a Topic. Typically, a subtopic may be identified by its subtopic header or other outline indicator. In different calculation contexts, subtopics may or may not be included as part of parent topics. The term "word_count" maybe understood as an integer count of the number of times a word or a word in its synonym group occurs in a given topic or text area, potentially including text in the title and headers and any text elements in that text. The term "word_frequency" may be understood to encompass the word count in a text area divided by the number of words total in that text. A word_map is a representation of textual content within a text area that is more precise than a word_count. A word_map
25 may describe a word's relative location in the text, its linguistic type or contexts of use,

5 its prominence indicators such as use in a title or highlighting fonts. The term
orthogonal corpus may be understood to encompass a collection of topically organized
information referenced by a table of contents and/or index, where each topic is clearly
identified as a SubTopic of a topic or else stands alone. Nodes in the table of contents
10 tree may represent topics. The information may be understood as orthogonal in the
sense that a stand-alone topic (e.g., chapter or article) covers a substantially different
concept than any other stand-alone topic, and any subtopic expresses a substantially
different concept from any other subtopic within the same parent topic. The term
document may be understood to encompass formatted textual content with topic
15 beginnings, endings, and marked hierarchy. A document may contain one or more
topics and may include subtopics. A corpus may include one or more documents. The
relationship between documents and topics is not mandated, though in some
embodiments each document to represent one top-level topic along with its subtopics.
The term "discovered document" may be understood to encompass a document (or a set
20 of documents such as a web site or portion of a web site) which is being scored. Scoring
of a discovered document may be relative to one or more corpus documents or corpus
topics. In one practice, scoring measures the degree of topical relevance to the corpus
topics. The discovered document will often be a member of a search result set.

25 More particularly, the systems and methods described herein include methods for
processing a body of reference material to generate a directory for accessing information
from a database. These methods may comprise processing the body of reference
material to identify a hierarchical organization of a plurality of topics. Additionally, the
processes may include the step of associating with at least one of the topics a portion of
the reference material and processing the assigned portion of reference material to
30 generate a plurality of search keys representative of search strings for selecting
information from the database. The process may then apply the search keys to the
database to retrieve information from the database and may create an association
between the at least one topic and the information retrieved from the database.

35 In an optional step, the methods described herein may create a graphical interface
that is representative of the identified hierarchical organization of a plurality of topics

5 for allowing a user to access information retrieved from the database and having an association with the topic. Accordingly, the user may be provided with a graphical interface that allows the user to activate, typically by clicking with a mouse, a graphical representation of a topic to identify a set of links to content, such as web pages that are associated with the topic selected by the user.

10 In one practice, processing the body of reference material includes processing a body of reference material that has been selected from the group consisting of an encyclopedia, a dictionary, a text book, a novel, a newspaper, or a website. Processing the material may include identifying a hierarchical organization of a plurality of substantially orthogonal topics. This may include identifying a table of contents for the
15 body of reference material, identifying an index for the reference material, identifying chapter or subchapter headings within the reference table, identifying definition entries within a dictionary, and other similar operations that identify different topics that occur within the reference material.

20 Optionally, when processing a body of reference material, the process may normalize the identified hierarchical organization of the plurality of topics.

25 In one practice when processing the assigned text, the process includes a step of generating a word map that is representative of a statistical analysis of the words contained in the assigned text. Generating the word map may include performing a word count process for determining word frequency of a word within the assigned text and for employing the word frequency for determining the relevance of a word to the associated topic. Processing the assigned text for different topics may also include a step of identifying a set of key words that have an associated measure intradocument orthogonality.

30 In an optional step, processing the assigned text may include identifying a set of synonyms for extending the search keys. Further, a subset of search keys may be selected that have a predetermined measure of correlation to the topic. The search keys may be applied to the database such as through an Internet search engine, to discover documents that are related to the search keys. Optionally, the Internet search engine may be a meta-search engine.

5 Once documents have been discovered from the database that are related to the search keys, documents may be further processed to determine their relationship to the topics associated with the search keys.

10 In the methods described herein creating an association between the at least one topic and the information retrieved from the database may include capturing a location pointer that is associated with the information retrieved from the database. Creating that association may include generating a data structure for the topic which allows storing location pointers that are associated with information retrieved from the database.

15 In another aspect, the systems and methods described herein include systems for organizing a collection of documents. Such systems may comprise an orthogonal corpus of information that is arranged according to an index of topics, a keyword generator for generating a set of keywords representative of a documents associated with a topic in the index of topics, a scoring system for processing documents within the collection of documents to associate with at least a portion of the documents a score representative of the document's association to a particular topic, and a graphical representation for
20 depicting at least a portion of the index of topics and having respective portions of the graphical representation linked to documents associated with a respective portion of the index of topics.

25 In a further embodiment the systems of the invention may include systems for extending the content of the document. These systems can include a parser for selecting terms within the document to be extended, an orthogonal corpus of information arranged according to an index of topics, a keyword generator for generating a set of key words representative of a documents association with a topic in the index of topics, and a linking system for processing the documents within a collection of documents, to associate with at least a portion of the document, a score representative of the documents
30 association to a particular topic and for providing the first document with links to the collection of documents for extending the content of that document.

35 Accordingly, the systems and methods described herein may leverage the electronically stored content of the World Wide Web in an intelligent and meaningful way, to provide a database of content organized under an orthogonal and hierarchical index of topics and subtopics.

5 Other objects of the invention will, in part, be obvious, and, in part, be shown from the following description of the systems and methods shown herein.

Brief Description of the Drawings

10 The foregoing and other objects and advantages of the invention will be appreciated more fully from the following further description thereof, with reference to the accompanying drawing wherein;

Figure 1 depicts a screen shot of a portion of a orthogonal corpus and a set of documents and the scores associated with those documents.

15 Figures 2A through 2B depict a dataflow diagram of one process according to the invention for processing a body of reference material for organizing a collection of documents according to a hierarchical arrangement of topics provided by the reference material;

Figure 3 depicts one flow chart diagram of a process according to the invention;

Figure 4 depicts one system according to the invention; and

20 Figures 5-9 depict a further practice according to the invention organizing content according to indices generated from a plurality of references.

Detailed Description of the Illustrated Embodiments

25 To provide an overall understanding of the invention, certain illustrative embodiments will now be described. However, it will be understood by one of ordinary skill in the art that the systems and methods described herein can be adapted and modified to provide systems and methods suitable for other applications and that other additions and modifications can be made to the illustrated embodiments without
30 departing from the scope hereof.

It is a realization of the invention that the indexing and cataloging of content on the Internet, as well as from other stores of information, may be performed by applying a process that employs an orthogonal corpus, or corpora, of information, such as an
35 Encyclopedia. To this end, the processes described herein identify the topics discussed

5 within the corpus. The process also identifies within the corpus a set of keywords that are relevant to the topics presented in the corpus. The keywords associated with a topic may be employed to identify documents stored in another database that are related to the topic. A graphical representation of the index of topics found in the corpus may then be generated, with individual topics operating as links to these related documents. Thus, a
10 user interested in reviewing content in the corpus related to a certain topic, may also activate a link in the graphical representation of the index to access other documents that have been identified as related to the topic of interest to the user.

Turning to Fig. 1, there is depicted a graphical user interface 10 of the type
15 created and employed by systems according to the invention. The graphical user interface 10 represents a topic index 12, a portion of which is shown in this illustration. The topic index 12 may be a graphical representation of the table of contents of an encyclopedia, or other corpus. A user may employ the graphic interface 10 to access information that relates to the different topics listed in the index 12. Additionally, the
20 depicted index 12 includes topics and subtopics, including subtopics of the same ancestor topic. For example, in Fig. 1, the topic Human Origins is the ancestor topic for the subtopics, The Study of Ancient Human and the Distribution of Early Hominids. A topic, or a subtopic, may be understood to include, optionally, its ancestor topics or underlying subtopics.

25 The graphical representation of the index 12 may include a hypertext link, or other linking mechanism, for each topic or subtopic in the index 12. For example, the user may activate the links, as depicted by the highlighted topic PHYSICS in Fig. 1, to retrieve a group of documents having content that is associated with the selected topic. As further depicted by Fig. 1, the system 10 may provide a display 20 such that for a
30 selected topic or a subtopic, such as the selected topic Physics, a document 18, or a plurality of documents 18, may be presented to the user as documents associated with the topic. In the depicted embodiment, a pointer to the document, such as the title and URL 14 may be presented to the user. Additionally, an associated numerical score 16,
35 that represents that document's association to the topic may also be presented. The

5 development of such scores 16 will be described in more detail hereinafter. Optionally, all the documents associated with a topic may be displayed in a window 20 of the system 10.

Turning now to Figures 2A and 2B, dataflow diagrams are presented that
10 illustrate one process for creating a graphical interface, such as the interface 10 of Fig. 1. Specifically, Figures 2A and 2B depict a process 30 wherein a corpus, such as an existing published book of reference material, is processed by an orthogonal corpus indexing (OCI) process that extracts content signatures and topic indices from the
15 corpus' content. The depicted process employs the content signatures to generate search strings for search engines to identify content associated with topics described in the corpus. The retrieved or discovered documents may be examined for content relevance and the relevant documents may be associated with topics presented in the orthogonal index of the corpus. Optionally, site attributes such as document type, timeliness, source and other such attributes may also be identified and employed to select relevant websites
20 that may be associated with a topic in the index of the orthogonal corpus.

More specifically Fig. 2A depicts that the process 30 operates on a corpus 32 that may be input to the index generator 34. The index generator 34 may generate an index for the corpus 32 and this index may be provided to the keyword generator 48. The
25 keyword generator 48 may produce a set of key words 52 and may be associated with the index 40. The process 30 continues in Figure 2B which shows the index 40 in the search keys 52 being applied to a search engine 54. The search engine 54 discovers documents from a database of content, or from a collection of databases of content 58 to thereby create an association between at least one of the topics of the index 40 and the
30 information retrieved from the database 58.

The depicted corpus 32 may be any collection of information and may include, but is not limited to, encyclopedias, text books, dictionaries, thesauruses, atlases, maps, and other reference material. In one embodiment, the corpus 32 may be a published
35 book that may be turned into or stored in an electronic format such as a conventional

5 computer datafile of text information. The corpus 32, preferably in an electronic format, may be provided to the index generator 34. The index generator 34 may process the corpus 32 to identify a hierarchical organization of a plurality of topics that appear within the corpus 32. To this end, the index generator 34 may decompose the corpus 32 to create a standard hierarchical topic orientation that is capable of assigning text content to title, headers, topics, subtopics, or any other device that may be employed for
10 representing a section of text related to a topic, meaning, category, or some other similar abstraction.

US Patent 5,963,203 entitled "*Automatic index creation for a word processor*"
15 issued to Sotomayor, Bernard, describes methods that may be employed by the index generator 34. For example, Sotomayor describes methods that enable scanning one or more documents to automatically identify key topics and phrases in a document's text, as well as methods to generate an index to those key topics. Similarly, US Patent 5,819,258 entitled "Method and apparatus for automatically generating hierarchical
20 categories from large document collections", by Vaithyanathan, Shivakumar, Travis, Robert, and Prakash, Mayank, further describes techniques that may be employed by the index generator 34 for determining an index for a corpus. Other techniques known in the art may also be employed by the index generator 34 without departing from the invention.

25 In an alternative practice, the index generator 34 allows an operator to identify the type of corpus 32 being input into the index generator 34. For example, the index generator 34 may present an interface to the operator that allows the operator to identify whether the corpus being presented comprises an encyclopedia, a dictionary, a
30 textbook, or another known type of reference document. Additionally, the index generator 34 may allow the operator to identify whether the corpus 32 includes a table of contents, an index, chapter heading, or any other representation of the different topics contained within the corpus. In this embodiment, the user may identify, for example, that the corpus 32 comprises an encyclopedia and that the encyclopedia includes a table
35 of contents that is representative of the index of orthogonal topics maintained within the

5 encyclopedia. In this embodiment, the index generator 34 may process the presented
corpus 32 to identify the table of contents for the encyclopedia. This table of contents,
in one embodiment, may be formatted into an HTML document that presents the table of
contents in an organized format that emphasizes the topics, subtopics and other
10 hierarchical structure of the table of contents. In one process the index generator 34
processes the notation for the table of contents, such as the topic numbering employed,
to identify which topics are understood as parent topics and which are understood as
main topics and which are understood as subtopics. In a further optional embodiment,
the index generator 34 may present the generated index with the orthogonal corpus 40 to
15 the operator to allow the operator to edit or amend the generated index for the
orthogonal corpus 40.

As shown in Figure 3B once the index generator 34 has processed the corpus 32
the index generator 34 may present the index 40 for the corpus 32 to the keyword
generator 34. As depicted in Figure 2A, the index 40 may comprise a hierarchical
20 representation of the orthogonal topics maintained within the corpus 32. This
hierarchical representation may include primary topics, such as the depicted topic 38 and
a plurality of subtopics 42 that are associated with the primary topic 38.

The keyword generator 48 in one embodiment operates to identify sections of text
25 of the corpus 32 to be associated with the different topics and subtopics of the index 40.
Continuing with the above example, in those practices where the index 40 is generated
from the table of contents for the corpus 32, the keyword generator 48 may identify
those pages that contain information associated with a topic presented within the index
40. For example, the keyword generator 48 may process the table of content for the
30 corpus 32 to identify a page number associated with a topic, such as the topic 40 and
may analyze the page associated with topic 40 to identify that portion of the page that
may be associated with the topic 40. In one embodiment, where headings are presented
within the corpus 32, the keyword generator 48 may analyze the page associated with
the topic 40 to identify a heading that is representative of the beginning of the
35 presentation within the corpus 32 of information that is associated with topic 40. For

5 example, the keyword generator 48 may identify a section of text within the associated page that contains the information associated with topic 40 and that is presented in a type font and font size that is representative of a heading. In a subsequent step the keyword generator 48 may identify the location of the heading for the subsequent topic 44 that indicates the beginning of content related to the new topic. The keyword
10 generator 48 may identify the content that is delimited by the heading 40 and 44 and associate that content as content related to the topic 40.

Once the portion of the corpus 32 that is to be associated with the topic 40 is identified, the keyword generator 48 may process this assigned portion of text to
15 generate a plurality of search keys, each of which may be representative of a search string for selecting information from a database.

In one embodiment, the system 10 employs the orthogonal construction of the corpus for algorithmic identification of keywords in each topic that distinguish that topic
20 from its sibling, cousin, ancestor, or descendent topics. Accordingly, the systems described herein may create a set of keywords for a topic that identifies a document associated with a topic and that are keywords which may act to distinguish documents associated with one topic, from documents associated with another topic. For example, the system 10 may employ processes that identify keywords that are associated strongly
25 with a particular topic. Techniques for creating keywords will be understood from Deerwester, S., Dumais, S.T., Landauer, T.K. Furnas, G.W. and Harshman, R.A. (1990), "Indexing by latent semantic analysis." *Journal of the Society for Information Science*, 41(6), 391-407. Additionally, the system 10 may identify other keywords that act to disassociate a document from one or more other topics. These keywords may be
30 employed by the system 10 to numerically score over an underlying pool of documents.

The system 10 may employ scoring methods that may utilize traditional information retrieval techniques including the use of synonyms, stemming, frequency, proximity, stop words, hyponyms, and synonyms. If, as in most large document
35 collections, it is not practical for all documents to be individually scored against the

5 keywords, then a subset of search words is selected to identify candidate documents for
scoring. Keyword and search terms are identified based on a numerical method that
apportions words among topics. The goal is for the keywords and search terms to
10 identify individual blocks of text as found at the nodes of the orthogonal corpus topic
hierarchy. In an ideal sense, the keywords would be partitioned across the hierarchical
tree nodes, with each word occurring in only one corpus topic. In addition to word rarity
among corpus topics, rarity in the underlying document pool may contribute to a word
being identified as a keyword or search term for a given topic. For example, a keyword
occurring in only one node and only once on the Web, would be a top candidate as a
keyword and search term.

15 The keyword generator 48 may present as an output, a set of keywords 52 each
of which may be associated with a topic or subtopic in the index 40. As described
above, these keywords may be employed to act to distinguish documents associated with
one topic from documents associated with another topic. Accordingly, as depicted in
20 Figure 2B the search keys 52 and associated topics on the index 40 may be presented to
the search engine 54 for retrieving information from a database or databases of content
58. To this end, the process 30 applies the search keys to the database 58 to retrieve
information from the database 58. In one practice as will be described in more detail
hereinafter, an optional step in process 30 is performed wherein the search keys 52 are
25 processed to identify a subset of search keys that may be employed for generating search
queries to one or more search engines, such as Internet search engines, to discover a set
of documents which are relevant to the topic of interest. Each of the resulting
documents may be examined in a subsequent step to determine the relevance of the
content contained within the index. The relevance may be scored, as further described
30 below, for identifying the relevance of that document, and the score may be employed
for ordering the sequence in which content is listed as being relevant to a particular
document.

Once the discovered documents are scored for relevance, the process 30 may
35 associate portions of the discovered documents to associated topics within the index 38.

5 In a practice wherein the database 58 includes links to URL's for websites, the process
30 may create a web database that contains website information such as URL's, types,
dates, topics, contents, size and editor notes that are inserted or updated in the database
from time to time. Information about the corpus 32 that has been processed, such as the
10 publisher, the ISBN, and other types of information needed to purchase the book through
an online transaction may also be stored. The search engine may then provide a
navigation tool that comprises the HTML representation of the index 38 wherein topics
and subtopics within the index 38 link to URL's of web content identified as being
related to the topic or subtopic selected by the user. Optionally, in certain embodiments,
15 the topics and subtopics may also include links to portions of the corpus 32 that are
related to the topic selected by the user. In this way, a user may select a topic presented
by the corpus 32 in view of the information presented by the corpus 32 and related
information stored on the World Wide Web. In other embodiments, other techniques are
employed for semantic processing and for determining a topic that may be associated
with a portion of text within the corpus.

20 The data flow diagram depicted in Figs. 2A and 2B may be implemented in a
data processing process wherein a data processing program processes the corpus and
generates an index that links topics in the corpus to information from a data sources,
such as the Internet. Turning now to Fig. 3, a flow chart illustration of one such process
25 is depicted. Specifically, Fig. 3 depicts a process 70 for extending a corpus by
identifying topics covered by that corpus and employing information stored in the
corpus and related to the topics to identify information in a database that is also related
to the topic. The process 70 also generates an optional graphical user interface, such as
the interface depicted in Fig. 1, that includes links for topics listed in the index, and that
30 may be employed by a user to access the information associated with the listed topics.

The process 70 begins with the act 72 of identifying a corpus that is to be
extended, such as by selecting a publication that contains reference material. In step 72,
the process 70 transforms, or casts, the corpus into a normal form for processing. In one
35 practice, this involves decomposing the document format of the corpus into a standard

5 hierarchical topic orientation with a mechanism for assigning text content to title, headers, topics, and sub-topics. Optionally, stop words, such as the common words "and", "them", and "within", are identifies and removed during normalization.

10 After normalization, the process 70 proceeds to step 78 wherein the corpus is processed to identify which portions of the corpus relate to which topic. In one practice wherein the corpus includes a table of contents, the process 70 analyzes the document format of the corpus to locate within the text headings associated with the different topics. For example, as described in the above cited publication US Patent 5,963,203
15 entitled "*Automatic index creation for a word processor*", header information set off by HTML tags may be identified to find indicia of topic entries in the document being processed. However, any technique for processing a document to identify the sections of text related to a topic may be applied, including other techniques for analyzing the mark up form language of the document.

20 Proceeding to step 80, the process 70 analyzes the topics to identify a signature that may be understood as representative of the semantics of the topic. In one practice, the process 70 creates a word map per topic and subtopic. To this end the process 70 in step 80 may create a summary representation of the words in the text based on the number of, location of, and proximity of words within each topic and sub-topic. Other
25 factors may be employed, or substituted for these. Statistics are maintained on different parts of the document structure such as titles, headings, paragraphs, sentences, and image.

30 Table I depicts that several topics may be identified within the corpus. For example, Table I depicts that the processed corpus includes the topics Archaeology, Argentina, Arithmetic, Art, and Astronomy.

<u>Topic</u>
Archaeology

Argentina
Arithmetic
Art
Astronomy

TABLE I

The process 70 in one practice may then determine for a given topic, the word count for the words that appear within the portion of text, or other content, associated with the respective topic. This is depicted in Table II, that shows an example of the word count, with stop words removed, for words that appear in the portion of the corpus related to the topic "Astronomy."

Word counts in Topic Astronomy	
Word	Count
actual	1
ad	1
adopted	1
advances	2
ancient	3
application	2
assigning	1
astronomer	2
astronomers	2
astronomical	5
Astronomy	12
astronomy	11
Astrophysicists	1
astrophysics	1

TABLE II

In process 70, after the word count, and other statistics are determined, signatures are generated using orthogonalization. For example, in one practice, given the word counts or word maps for all or a selected subset of topics simultaneously, the process 70

5 assigns a weight based on word count to each word within each topic or subtopic. Where using word counts the weight may be defined as the count. When using the word map, the weight of a word in a topic or subtopic may be assigned by an intra-document scoring function. Any suitable technique may be employed for performing intra-document scoring. These signatures may be edited or cleaned manually to enhance the topical relevance and precision of the subsequent search and scoring process. Table III depicts an example signature for the topic "Astronomy."

Signature for topic Astronomy	
Word	Count
Astronomy	23
earth	9
bodies	5
Astronomical	5
universe	4
celestial	3
circle	3
Observational	3
sky	3
Stars	3
Ancient	3
Daily	3
Heavenly	2
Astronomers	2
planet	2
relative	2
moved	2
heavens	2

TABLE III

After determining a signature, the process 70 may perform the optional step, step 82, of applying synonym Groups. In this optional step, the process 70 extends the

signatures with synonym groups. To this end, words are replaced by groups of word substitutes having similar or identical meaning. Table IV depicts such an extension.

Astronomy Signature Post Synonym Reduction	
Word	Count
Astronom	30
earth	9
bodies	5
universe	4
celestial	3
circle	3
Observational	3
sky	3
stars	3
ancient	3
daily	3
Heavenly	2
planet	2
relative	2
moved	2
heavens	2

TABLE IV

After step 82, the process 70 may proceed to step 84, wherein the process reduces the signature to Keyword sets, optionally tailored for the search. The set of documents to be scored against a topic is preferably identified and manageable in size. The web for example is a large a document set to collect up and score against all web documents. Accordingly, in one practice traditional large scale search engines, such a Lycos and Alta Vista, may be used to identify a set of candidate relevant documents using a keyword set for search. Which subset of the Signature and synonym groups is included in the Keyword set may be determined based on a variety of measures

5 including corpus document word count of the word and general frequency of the word.
An example is presented in TABLE V.

Word	Count
Astronomy	30
Earth	9
Bodies	5
Universe	4
Celestial	3
Circle	3
Observational	3
Sky	3
Stars	3
Ancient	3
Daily	3

TABLE V

25 The keyword set may be applied to a search mechanism to pull in multiple
discovered documents based on the keyword set. This may occur in step 88. For
example, the query Find: Astronomy or Astronomical or Astronomers or earth or bodies
or universe or celestial or circle or Observational or sky or stars or ancient or daily; may
be generated from the keyword set and applied to the search mechanism to discover
documents related to the selected topic.

30 After the step 88, the process 70 may proceed to step 90 for scoring of the
discovered documents. The many discovered documents returned from a search
function may be assigned individual scores against the corresponding corpus topics and
subtopics. Scoring may be based on multiple tunable metrics and rules including
35 functions over the word count or word_map data structures. The score of topical overlap
between two documents as a baseline is measured as a dot product of word counts or
word frequencies within those documents).

5 Scoring example

Word	Count in Astronomy	Count in discovered document	Score Contribution
Astronom	30	2	0.555556
earth	9	1	0.083333
bodies	5		
universe	4	5	0.185185
celestial	3		
circle	3	2	0.055556
Observational	3		
sky	3		
stars	3		
ancient	3	1	0.027778
daily	3	2	0.055556
Heavenly	2		
planet	2		
relative	2		
moved	2	1	0.018519
heavens	2	1	0.018519

25 After step 90, the process 70 proceeds to optional step 92, wherein the topic hierarchy and set of associated documents may be presented directly through an HTML or graphical user interface, such as the interface depicted in Fig. 1. Alternatively, content may be delivered through software API's (application program interfaces) to allow integration of output content with other content. Content may be navigated by

30 walking the directory tree structure, or by keyword searching over the directory structure trees, corpus content, or discovered document content. Search results may point to topic paths or discovered documents,

Fig. 4 depicts one embodiment of the system 100 according to the invention.

35 Specifically Figure 4 depicts a functional block diagram that shows a system 100 that allows a surfer 102 to access a user interface 104 that couples to a database system 108. The database system 108 further couples to an OCI processor 112 that accesses a database of corpora 114 and a plurality of search engines 118. The database system 108 further couples to an application programming interface access layer 120 and through

40 the API 120 can access a portal/search client 122. Additionally, the API 120 may also couple to a scoring mechanism 124.

5 More particularly, Figure 4 depicts that a user 102 such as an Internet user may access a user interface 104, that may be similar to the user interface depicted in Figure 1. As shown in Figure 1 the user interface 10 may present to the user 102 a list of topics 112. The user 102 may select a topic from the index 112. As described with reference to Figure 1, the selection of a link directs the user interface 104 to retrieve information from the database system 108. The database system 108 processes the users request
10 from user 102 for information related to the selected topic.

 The database system 108 may be any suitable database system, including the commercially available Microsoft Access database, and can be a local or distributed
15 database system. The design and development of suitable database systems are described in McGovern et al., *A Guide To Sybase and SQL Server*, Addison-Wesley (1993). The database 108 can be supported by any suitable persistent data memory, such as a hard disk drive, RAID system, tape drive system, floppy diskette, or any other suitable system.

20 As further depicted by Figure 4 that database system 108 may communicate with the OCI mechanism 112. The OCI mechanism 112 may be, in one embodiment, a computer process capable of implementing a process such as process 70 depicted in Figure 3. The OCI mechanism can be realized as a software component operating on a
25 conventional data processing system such as a Unix workstation. In that embodiment, the OCI mechanism can be implemented as a C language computer program, or a computer program written in any high level language including C++, Fortran, Java or basic. Techniques for high level programming are known, and set forth in, for example, Stephen G. Kochan, *Programming in C*, Hayden Publishing (1983). Accordingly, the
30 OCI mechanism 112 may be employed by a system administrator to process corpora stored within the database 114. As discussed with reference to Figure 3, the processed corpora results in a graphical user interface that may be stored within the database mechanism 108 and accessed by the user 102 through the topic navigator 104. Additionally, the OCI mechanism 112 may generate for the processed corpora of
35 database 114 a set of links or pointers to content that corresponds with different listed

5 topics within the index of the processed corpora. The OCI mechanism 112 may also store these associated links within the database system 108.

10 To this end, the OCI mechanism 112 may couple to one or more search engines 118 that allow the OCI mechanism 112 to retrieve content from a database source. In the depicted embodiment of Figure 4, the database source that search engines 118 access is the World Wide Web 106. In this embodiment, the user interface 104 also couples to the World Wide Web 106 so that links activated by the user that relate to URL's of content stored on the World Wide Web 106 may be directly accessed by the user 102 through the user interface 104 through the connection between the user interface 104 and the World Wide Web 106. Figure 4 further depicts that the database 108 communicated with an API layer 120. As shown in Figure 4 the API layer sits between the portal search client 122 and the database system 108 and also sits between the scoring mechanism 124 and the database system 108. Accordingly, a portal search client such as the Yahoo site may access the database system 108 through the API layer to provide users with access to an index linked to content on the World Wide Web.

25 Similarly, Figure 4 depicts the scoring mechanism 124. The scoring mechanism 124 may be a computer process that accesses the database system 108 through the API 120. The scoring mechanism may perform data mining for identifying topics that are to be associated with different websites. In this way, the database system 108 may be employed for categorizing web sites according to their content. Thus, the system 100 depicted in Figure 4 provides a system for categorizing information stored on the World Wide Web. The system described in Fig. 4 may operate on any suitable computer hardware, such as PC compatible computer systems, Sun workstations, or any other suitable hardware. The list of topics and the associated documents, or links to documents may then be stored in a relational database, or any suitable database with proper indexing for allowing rapid accessing of the data stored therein.

5 Once the system is operating, the system may be employed to provide a set of tools, such as that may operate as stand alone applications for single users, or that may be tools provided as client/server programs over a network. The tools may be provided as a collection of functions incorporated into an integrated research tool, or may co-exist as individual functions in a separate application.

10 Further embodiment, the systems and methods described herein may be employed for organizing a plurality of corpora into an indexed format that may be presented as a graphical user interface for a user to allow a user to access information related to the contents of a plurality of corpora. For example, figures 5 through 9 depict
15 the operation of a system that processes a plurality of text, such as reference texts. Accordingly, the system may be employed for the automatic creation of a topically organized book catalog, such as a catalog of reference books, with navigation, search, click through to external documents such as web documents, with information purchasing interfaces also. For example, figure 5 depicts a graphical user interface that
20 presents to a user a plurality of topics each having a set of books within the topic. For example, the figure 5 depicts a topic reference that includes a set of encyclopedias and dictionaries within that reference. By activating the reference link, the user may be presented with the user interface shown in figure 6. Figure 6, the individual references presented under the reference topic of figure 5 are outlined for the user allowing the user
25 to select what type of reference the user would like to view.

 For example, the user may select from encyclopedias, dictionaries, academic and learned society publications and other such publications. After making a selection figure 6, the user may be presented with the different books under each category. The
30 example presented in figures 5 through 9 shows that upon activating the link for encyclopedias, the user is presented with the different encyclopedias that have been processed by the system according to the invention. Upon selecting a link, such as the link for the Encyclopedia Britannica, the user may be presented with the interface shown in figure 8 that lists the different topics covered by the Encyclopedia Britannica. At this
35 level, the process now proceeds as described above, with reference to figures 1 through 4

5 wherein the individual topics maintained within the Encyclopedia Britannica may be employed for accessing contact, such as web contact particularly associated with the individual topics.

10 Those skilled in the art will know or be able to ascertain using no more than routine experimentation, many equivalents to the embodiments and practices described herein. For example, the systems and methods described herein may be employed for providing encyclopedia (i.e., corpus) extender. An encyclopedia (as an archetype example of an orthogonal corpus) may be automatically extended by application of the systems and methods described above, to include links into the World Wide Web, or
15 other database, via searching or meta-searching over the Web. The breadth and depth of the corpus enables a high quality, high coverage database of web links, with the web links organized according to the location in the topic hierarchy whose text was used to generate them. Such links may provide geographical maps, histories of topics of interest, access to theses and other types of information. Other applications include
20 web book companions wherein the system processes a book, including a fictional work, a non-fictional work, or a reference book, through this system will allow automated construction of topical web sites as Web Companions to individual books. For example, a book such as the Hunt for Red October may be processed by the systems described herein to create links into the Web to documents associated with concepts from the
25 book, such as links to the Navy Submarine division, links to topographic maps of the ocean floor, links to Russian Naval History, and other similar links.

A search engine extension may be provided by accessing the database 108 through the API. Thus a user may do a search on a web search engine, they may want to
30 refine their search or get a second search opinion. Given a broad topic database such as that created in the Encyclopedia Extender application described above, refinement of a user's intended topic is enabled – through keyword-based narrowing, web link browsing, and display of proximal or correlated topics in the corpus topic hierarchy. For e-commerce, the systems described herein book/article browser/seller. Browsing over the
35 topic hierarchy may provide indexes into books or articles for sale.

5 Additional applications can include a user Interface. The user interface allows users to view Web links through the topic hierarchies defined by the corpus. The topic hierarchy on the left lists the topics as per the corpus. The user may select keywords from the corpus outline, or from provided sample text inside the corpus documents, to better focus and score the topic. Users may augment the search terms or keywords with their own keywords or selected synonyms to more specifically tailor a concept to a need. Searching across the corpus or across the referenced links may include synonyms, stemming, frequency, proximity, stop words, hyponyms, and synonyms.

10 Additionally, authoring toolkits may be provided that allow publishers, editors, and authors to create corpus extensions and associated applications. For example, the systems and methods described herein may be employed to create development kits that publishers may use to index a book and create a web site that acts as the book companion described above.

15 It may be noted that human oversight or auditing of the document scoring and database may be done in order to augment the purely automated document selection. This may be done on a sampling basis for quality control. Different levels of sensitivity to content or product price points may be implied by different levels of human quality control. Moreover, it will be noted that the system described above has been done so with reference to documents stored on the Web. However, it will be understood by those of ordinary skill in the art, that the Web is being used here as a metaphor for any electronic document archive, and the systems and methods described herein are not limited to the Web.

20 Accordingly, it will be understood that the invention is not to be limited to the embodiments disclosed herein, that other applications, such as information mining may be practiced with the systems and methods described herein, and that the invention is to be understood by the following claims which are to be interpreted as broadly as allowed under the law.

5

We claim:

1. A method for processing a body of reference material to generate a directory for accessing information from a database, comprising

10 processing the body of reference material to identify a hierarchical organization of a plurality of topics,

 associating with at least one of said topics a portion of the reference material,
 processing said assigned portion of the reference material to generate a plurality
15 of search keys representative of search strings for selecting information from the database,

 applying the search keys to the database to retrieve information from the database, and

 creating an association between the at least one topic and the information retrieved from the database.

20

2. A method according to claim 1, further comprising
 creating a graphical interface representative of the identified hierarchical organization of a plurality of topics for allowing a user to access information retrieved from the database and having an association with a topic.

25

3. A method according to claim 1, wherein processing the body of reference material includes processing a body of reference material selected from the group consisting of an encyclopedia, a dictionary, a text book, a novel, a newspaper, a web site, and [Henry what else are we interested in processing?].

30

4. A method according to claim 1, wherein processing the body of reference material includes processing the body of reference material to identify a hierarchical organization of a plurality of substantially orthogonal topics.

35

5. A method according to claim 4, wherein processing the body of reference

- 5 material includes identifying a table of contents for the body of reference material.
6. A method according to claim 4, wherein processing the body of reference material includes identifying chapter headings.
- 10 7. A method according to claim 4, wherein processing the body of reference material includes identifying definition entries in a dictionary.
- 15 8. A method according to claim 4, wherein processing the body of reference material includes normalizing the identified hierarchical organization of a plurality of topics. [Henry - here we are interested in any things we do to process the hierarchical organization to make the topics more orthogonal].
- 20 9. A method according to claim 1, wherein processing the assigned text includes generating a word map representative of a statistical analysis of words contained in the assigned text.
- 25 10. A method according to claim 9, wherein generating the word map includes performing a word count process for determining word frequency of a word within the assigned text, and for employing the word frequency for determining relevance of a word to the associated topic.
- 30 11. A method according to claim 1, wherein processing the assigned text includes processing the assigned text to identify a set of keywords having an associated measure of intra document orthogonality.
12. A method according to claim 1, wherein processing the assigned text includes identifying a set of synonyms for extending the search keys.
- 15 13. A method according to claim 1, wherein processing the assigned text includes

5 selecting a subset of the search keys having a predetermined measure of correlation to the topic.

14. A method according to claim 1, wherein applying the search keys to the database includes applying the search keys to an Internet search engine to discover
10 documents related to the search keys.

15. A method according to claim 1, wherein applying the search keys to the database includes applying the search keys to a meta-search engine to discover documents related to the search keys.

16. A method according to claims 14 or 15, wherein applying the search keys to the database includes processing text of the discovered documents to identify documents related to the topics associated with the search keys.

17. A method according to claim 1, wherein creating an association between the at least one topic and the information retrieved from the database includes capturing a location pointer associated with the information retrieved from the database.

18. A method according to claim 1, wherein creating an association between the at least one topic and the information retrieved from the database includes creating a data structure for the topic for storing location pointers associated with information retrieved from the database.

19. A system for organizing a collection of documents, comprising
30 an orthogonal corpus of information arranged according to an index of topics,
a keyword generator for generating a set of keywords representative of a document's association with a topic in the index of topics,
a scoring system for processing documents within the collection of documents, to associate with at least a portion of the documents, a score representative of the
35 document's association to a particular topic, and

5 a graphical representation for depicting at least a portion of the index of topic and
having respective portions of the graphical representation linked to documents
associated with a respective portion of the index of topics.

20. A system for extending the content of a first document, comprising
10 a parser for selecting terms with said first document to be extended,
 an orthogonal corpus of information arranged according to the index of topics,
 a keyword generator for generating a set of keywords representative of a
document's association with a topic in the index of topics, and
 a linking system for processing documents within a collection of documents, to
15 associate with at least a portion of the documents, a score representative of the
document's association to a particular topic, and for providing said first document with
links into said collection of documents for extending the content of said document.

10

Corpus Navigator
File Help Edit

Corpus Narrowing and Refinement

12

Baha'i Faith
Balkan War
Chemistry
French Literature
Human Origins
THE STUDY OF ANCIENT HUMANS
- Estimating the Age of Finds
- Distribution of Early Hominids
Painting
Philosophy
Physics
History
Scientific Methods Used in Physics
Galileo Finds Modern Mechanics
Newtonian and Relativistics Mechanics
Old and New Concepts of Heat
The Problem of Explaining Light
Some Major Figures in Modern Physics
BIBLIOGRAPHY FOR PHYSICS
Chemistry
Bio Chemistry
Physical Chemistry
Piaget, Jean
Phlox
Reproductive System

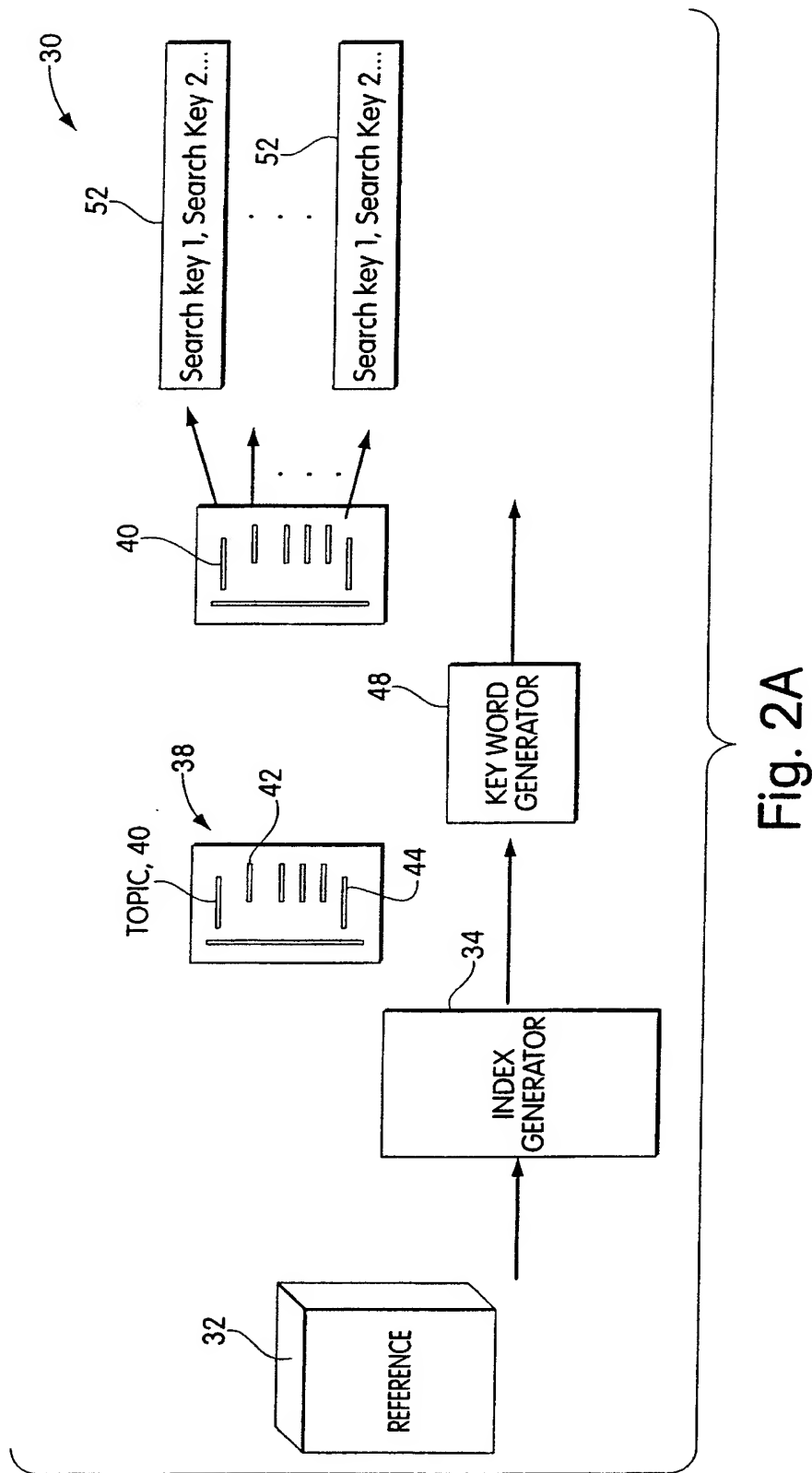
16 14 18

Score [10.4] Department of Physics, <http://www.boun.edu.tr/~yazoku/phys.html>
 Score [9.5] Amazon.com: Table of Contents: Physics for Scientists and Engineers
<http://www.amazon.com/exec/obidos/its/book-contents/0134329805/qid=912039041/sr=1-11>
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<http://www.phys.canterbury.ac.nz/courses98/phys100/phys102.html>
 Score [7.6] Syllabus for Physics 104 <http://alpha.centenary.edu/syllabus/sylph104.html>
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<http://www.amazon.com/exec/obidos/its/book-contents/0471539546/1/>
 Score [11.4] The Progress of Science [1887] <http://aleph0.clarku.edu/huxley/CE1/PoSci.html>
 Score [11.2] ECTS Page - Faculty of Physics and Astronomy, Jena <http://www.physik.uni-jena.de/ects.html>
 Score [11.1] The Space - Time Universe <http://www.randomc.com/~rs/Articles/SpaceTimeUniverse.html>

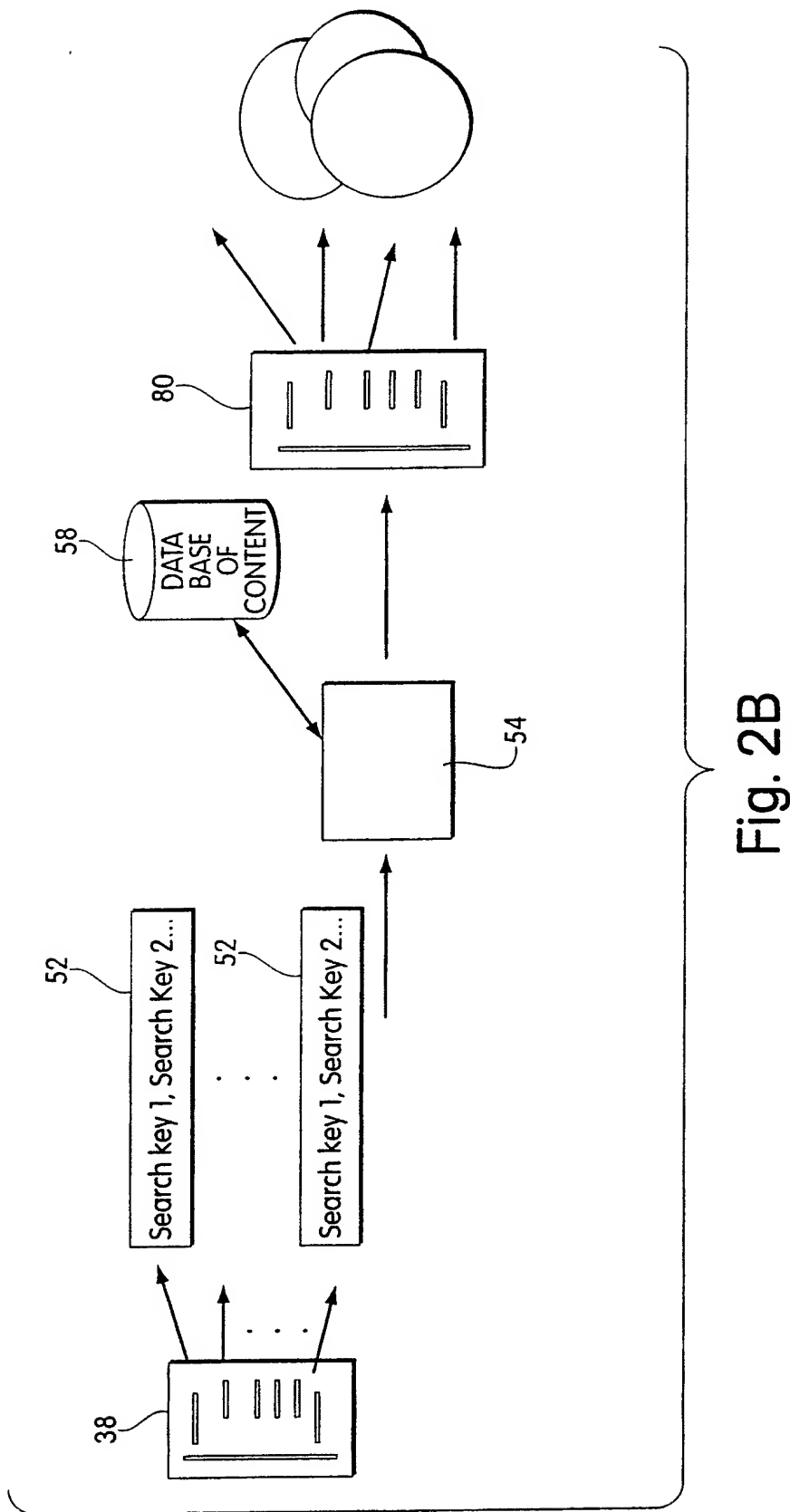
Solution Update succeeded

Ln 110 Col 1 Ch 1

Fig. 1



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4/10

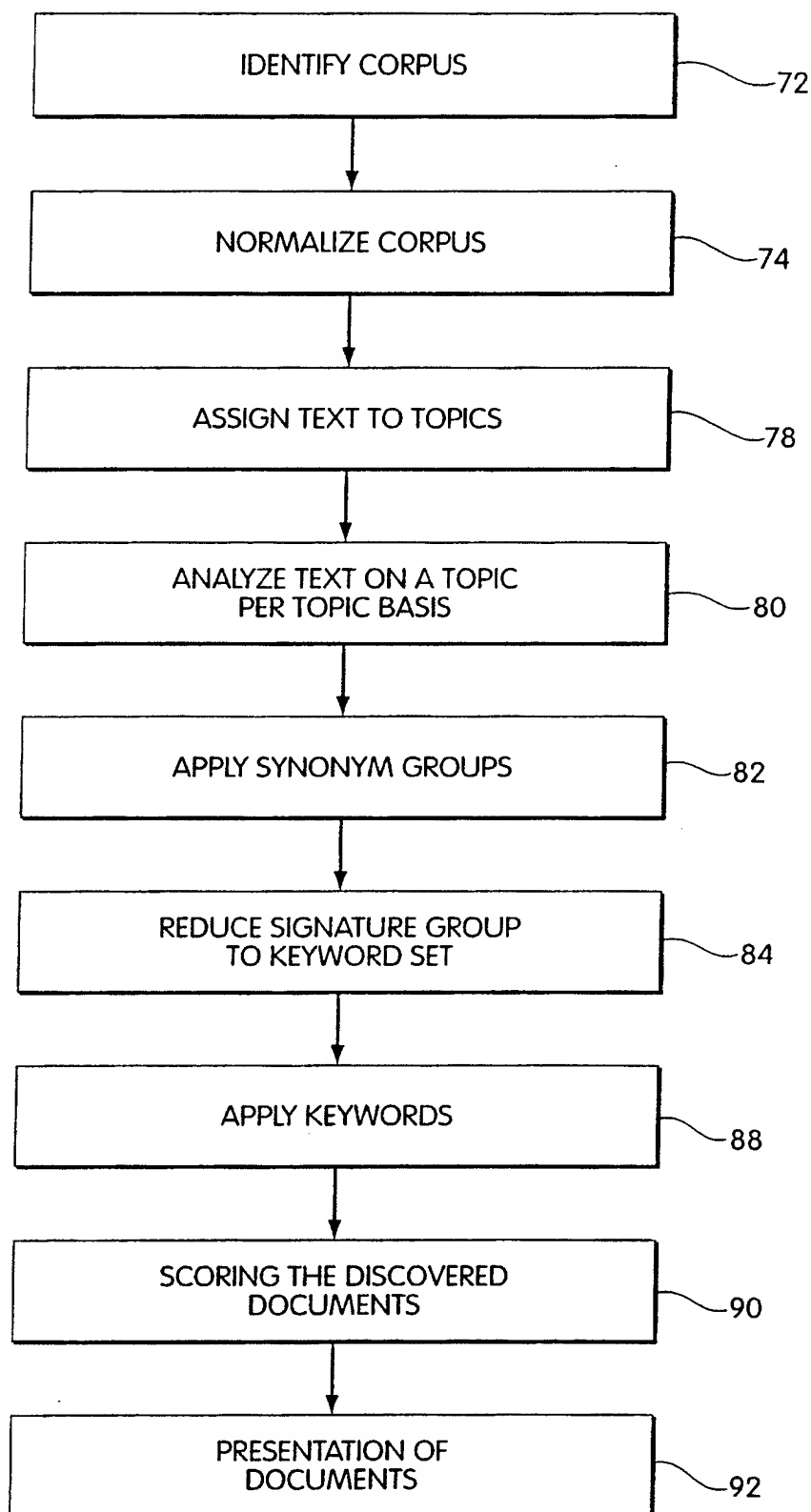


Fig. 3

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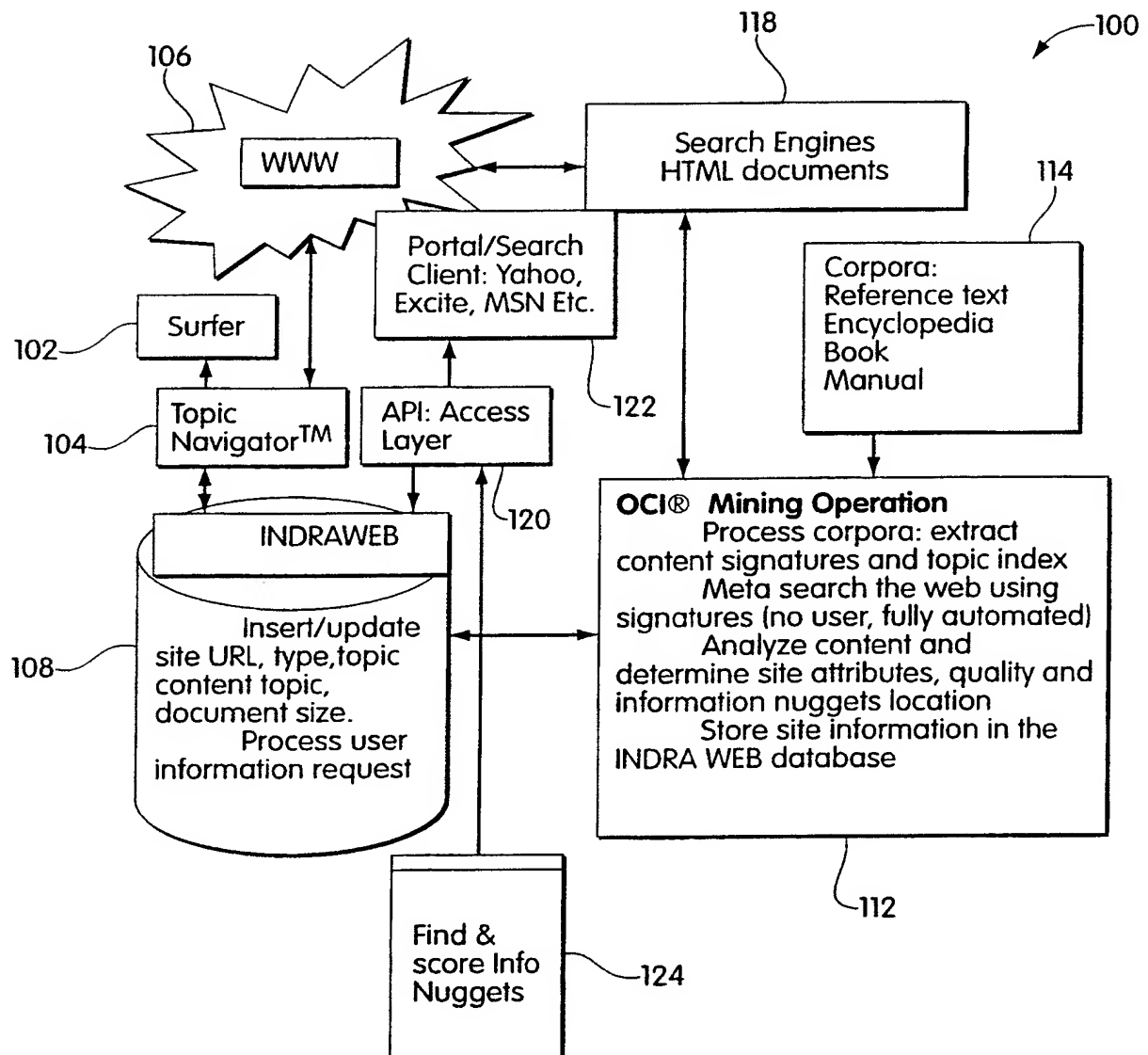


Fig. 4

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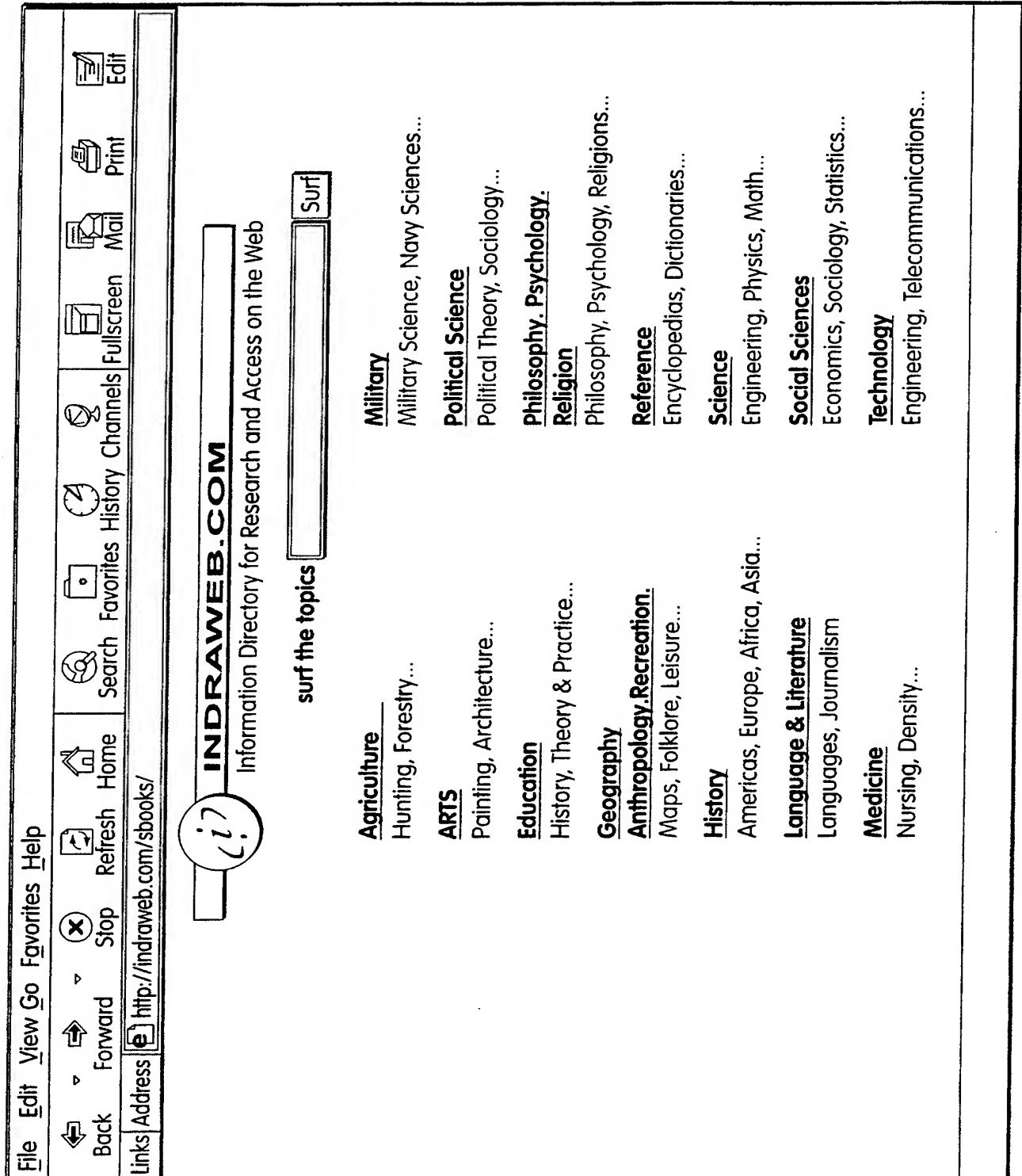


Fig. 5

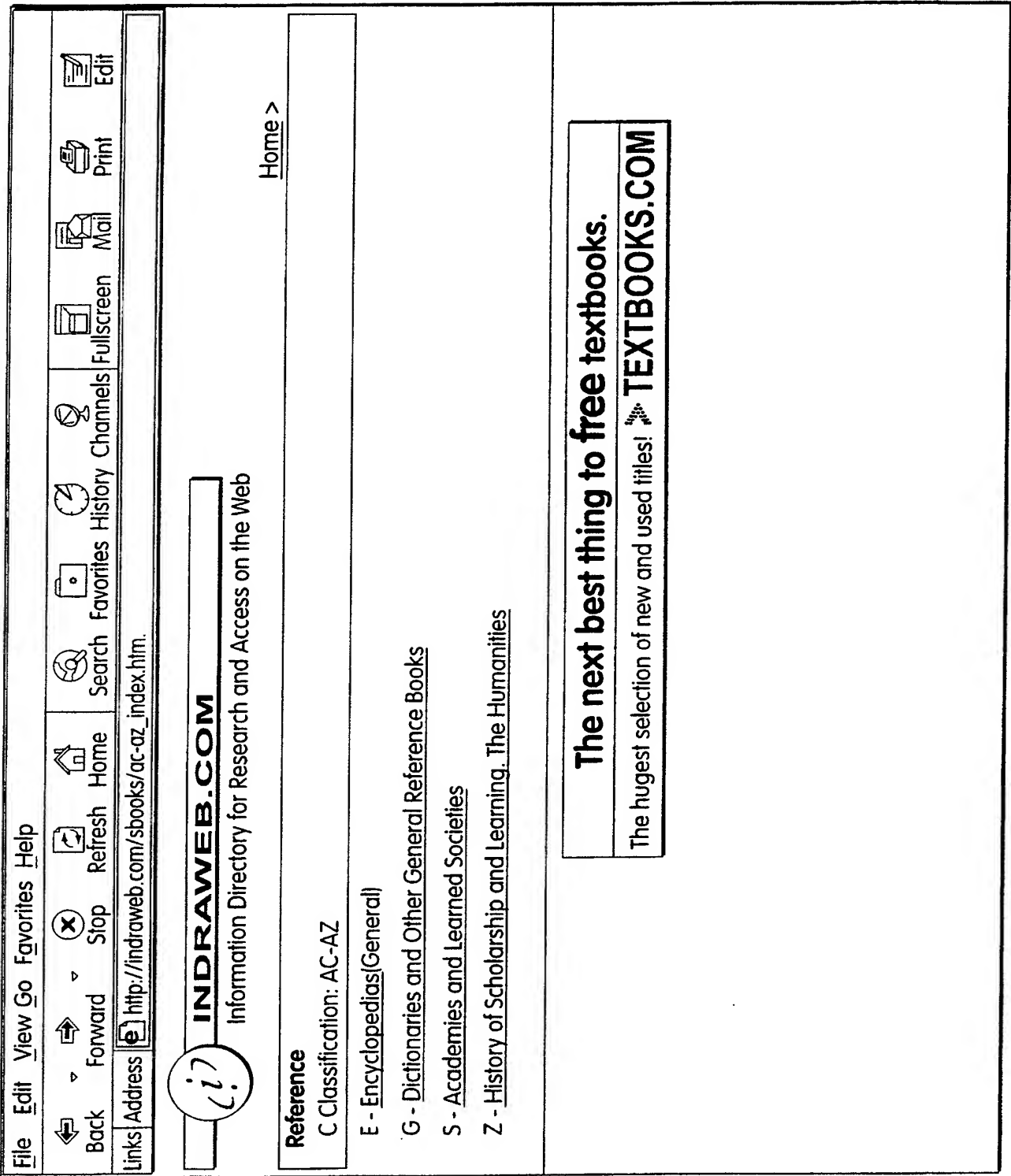


Fig. 6

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Fig. 7

File Edit View Go Favorites Help									
Back	Forward	Stop	Refresh	Home	Search	Favorites	History	Channels	Full Screen
Links Address					http://indraweb.com/sbooks/ae.htm				
Home > Reference >									
Encyclopedias (General)									
Omne bonum : a fourteenth-century encyclopedia of universal knowledge : British Library MSS Royal 6 E VI-6 E VII					1996	AE2.L463 S26	H. Miller Publishers		
Academic American encyclopedia.					1998	AE5 .A23	Grolier Inc.		
Encyclopedia Britannica					1997	AE5 .B	Routledge		
The Cambridge paperback encyclopedia					1995	AE5 .C36	Cambridge University Press		
Cambridge paperback encyclopedia					1993	AE5 .C36	Cambridge University Press		
Collier's encyclopedia : with bibliography and index					1997	AE5 .C683	Collier's		
The Encyclopedia Americana.					1999	AE5 .E333	Grolier Incorporated		
Encyclopedia of knowledge					1991	AE5 .E478	Grolier		
Family encyclopedia.					1997	AE5 .F36	Oxford University Press		
Funk & Wagnalls new encyclopedia					1996	AE5 .F83	Funk & Wagnalls		
The Macmillan compact encyclopedia					1991	AE5 .M24	Macmillan		
Merit students encyclopedia					1993	AE5 .M38	Macmillan Educational Co.		
New standard encyclopedia.					1998	AE5 .N64	Ferguson Pub. Co.		
Oxford illustrated encyclopedia					1993	AE5 .O94	Oxford University Pre		
Webster's family encyclopedia.					1992	AE5 .W35	Merriam-Webster, Inc		
The World Book encyclopedia.					1999	AE5 .W55	World Book		
The World Book encyclopedia of people and places.					1998	AE5 .W563	World Book		

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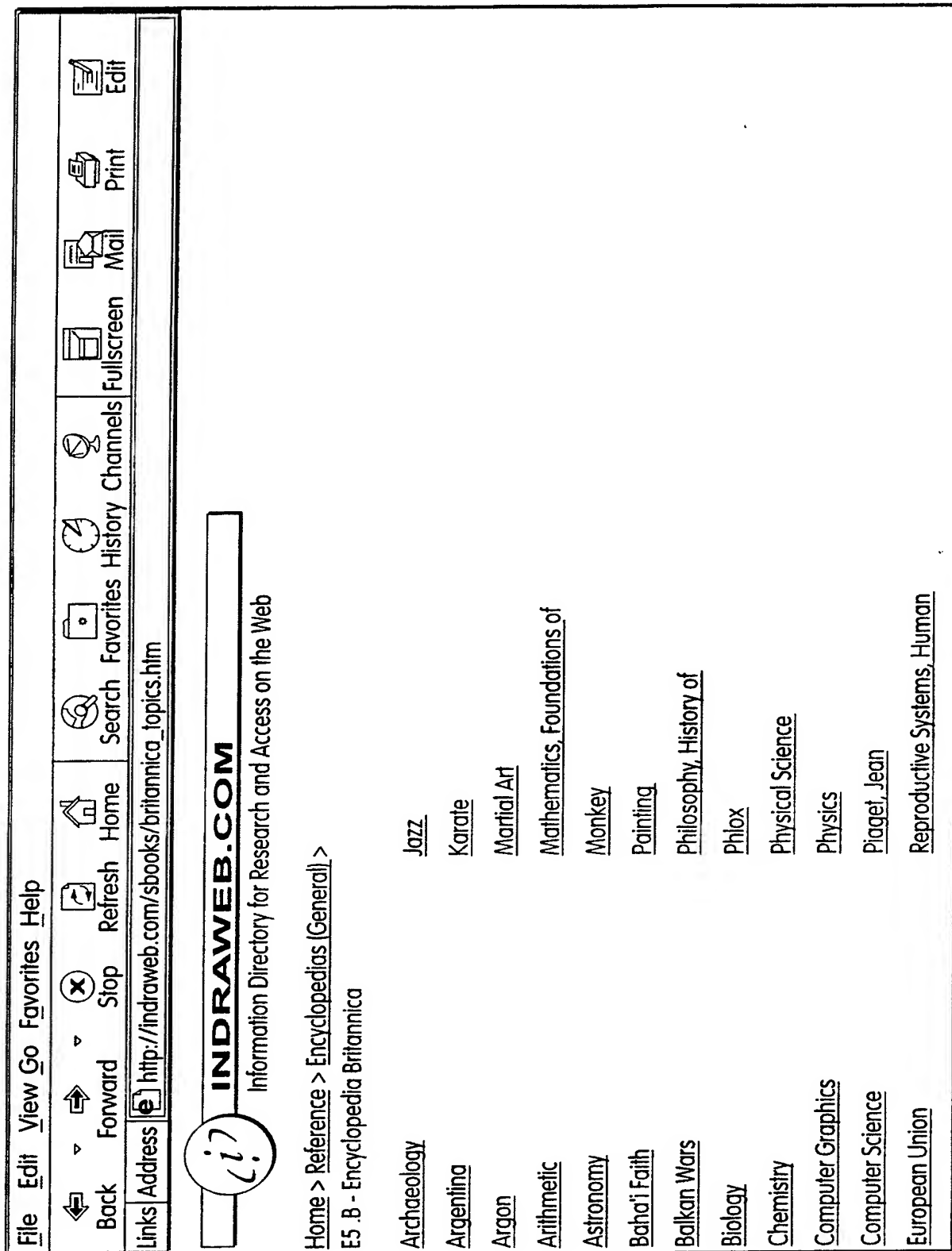


Fig. 8

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File	Edit	View	Go	Favorites	Help
Back	Forward	Stop	Refresh	Home	Search
Channels	Full Screen	Mail	Print	Edit	

Address <http://indraweb.com/sbooks/astronomy.htm>

Home > Reference > Encyclopedias (General) > Encyclopedia Britannica > **Encyclopedia Britannica / Astronomy**

Search: astronomy earth bodies astronomical universe celestial circle observational sky stars ancient daily heavenly astronomers planet relative moved heavens ray ptolomatic copernicus revolution recognized electronic advances position rad (Any word)

Found: 277 document(s) on The Web Sort: S

Imagine the Universe! Dictionary
Please allow the whole page to load before you start searching for an entry. Otherwise, errors will occur. [A B C D E F G H I J K L M N O P Q R S T U V W X Y Z]

Found by: Infoseek, WebCrawler
<http://imagine.gsfc.nasa.gov/docs/dictionary.html>

APOD Glossary
Astronomy Picture of the Day Glossary Cepheid: A pulsating variable star. This type of star undergoes a rhythmic pulsation as indicated by its regular pattern of changing brightness as a function of time.
Found by: WebCrawler
<http://antwrp.gsfc.nasa.gov/apod/lib/glossary.html>

ASTRONOMY
In this page I've written something about. ASTRONOMY. Version en Castellano. WE CAN ALWAYS LEARN SOMETHING NEW ! Astronomy is the science of heavenly ...
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<http://www.geocities.com/Yosemite/Tails/7812/e-astronomia.html>
<http://chandra.bgsu.edu/~gcd/Spacetime6.html>
Back to the course home page. Back to Table of Contents. Chapter 6 The Transition from Aristotle to Newton I. Introduction The purpose of this chapter is to describe, in broad outlines, the contributions to the theory of space and time which were..
Found by: HotBot
<http://chandra.bgsu.edu/~gcd/Spacetime6.html>

Expanding Universe: Astronomy
520 : 525 - Astronomy and Allied Sciences. 520 522 523 525. General astronomy sites, periodicals, associations, planetariums Observatories, ...
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<http://www.mird.toronto.on.ca/centres/bsd/astronomy/520-25.HTM>

The Atheism of Astronomy
Library: Historical Documents: Woolsey Teller: Atheism Of Astronomy The Atheism Of Astronomy: A Refutation Of The Theory That The Universe Is Governed

Fig. 9